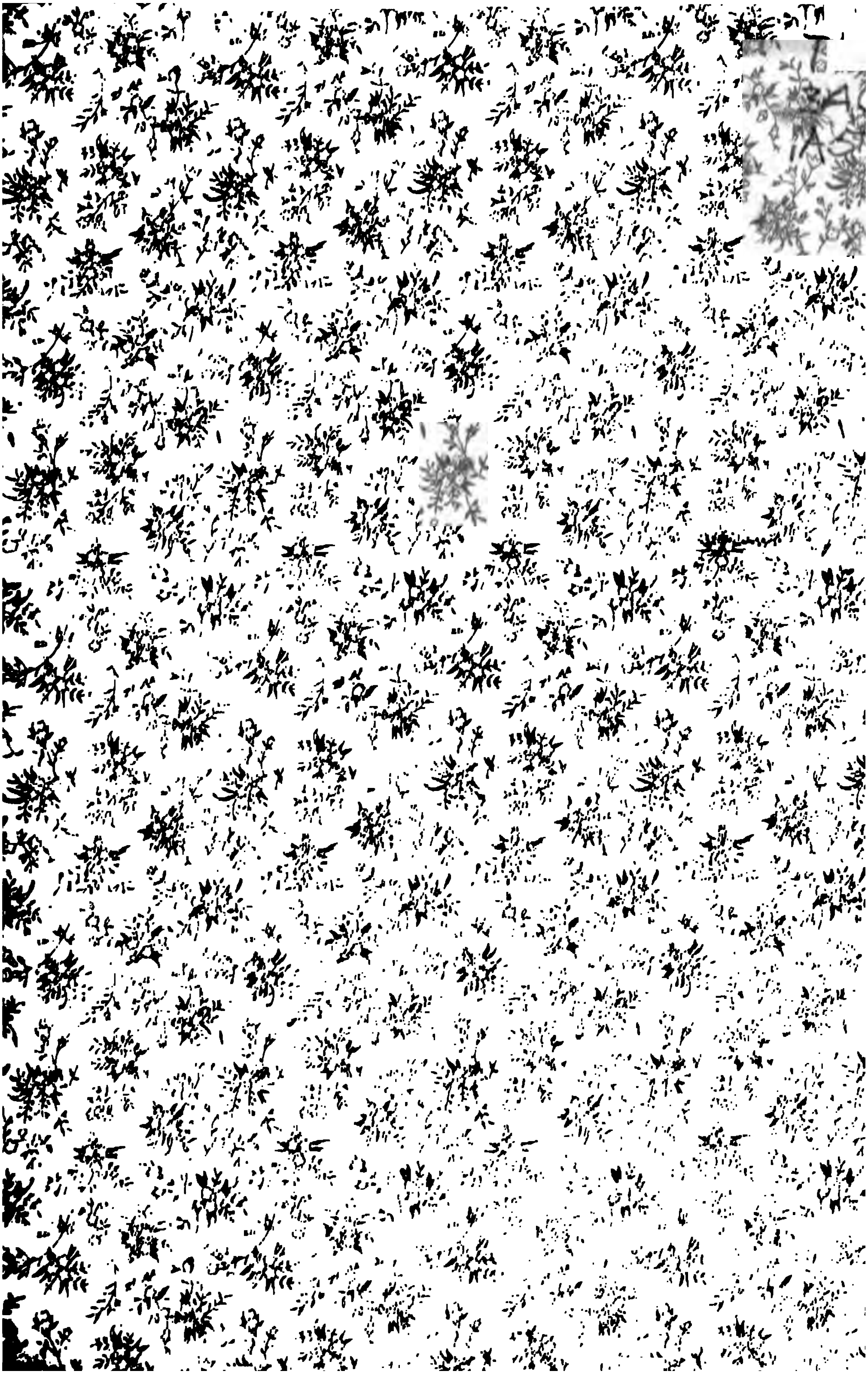

# REPORT OF THE PROCEEDINGS

OF THE

# Thirty-first Annual Convention

OF THE

# AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

(*INCORPORATED*)

HELD AT

## SARATOGA, NEW YORK,

*June 20, 21 and 22, 1898.*

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CHICAGO:
THE HENRY O. SHEPARD COMPANY,
212-214 MONROE STREET.
1898.

# AMERICAN RAILWAY

# MASTER MECHANICS' ASSOCIATION

(*INCORPORATED*).

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## OFFICERS FOR 1898-99:

PRESIDENT:
ROBERT QUAYLE,
Chicago.

FIRST VICE-PRESIDENT:
J. H. McCONNELL,
Omaha, Neb.

SECOND VICE-PRESIDENT:
W. S. MORRIS,
Richmond, Va.

THIRD VICE-PRESIDENT:
A. M. WAITT,
Cleveland, Ohio.

TREASURER:
J. N. BARR,
Milwaukee, Wis.

SECRETARY:
JOHN W. CLOUD,
Chicago, Ill.

# COMMITTEES FOR CONDUCTING THE BUSINESS

FOR THE

## YEARS 1898-99.

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### SUBJECTS FOR 1899 CONVENTION.

*1.—A Research Laboratory under the Control of the Association.*

WM. FORSYTH,
W. F. M. GOSS,
JOHN PLAYER.

*2.—The Best Methods of Preventing Trouble in Boilers from Water Impurities.*

A. E. MANCHESTER,
J. H. MANNING,
S. P. BUSH,
H. BARTLETT,
R. M. GALBRAITH.

*3.—Relative Merits of Cast-Iron and Steel-Tired Wheels for Locomotives and Passenger Car Equipment.*

J. N. BARR,
H. S. HAYWARD,
A. M. WAITT.

*4.—Advantages of the Ton-Mile Basis for Motive Power Statistics.*

H. J. SMALL,
C. H. QUEREAU,
W. H. MARSHALL.

5.—*Best Method of Applying Stay Bolts to Locomotive Boilers, Including Making the Bolts and Preparing the Stay-Bolt Holes.*

G. F. WILSON,
S. M. VAUCLAIN,
T. A. LAWES.

6.—*Is it Desirable to have Flanged Tires on All the Drivers of Mogul, Ten-Wheel and Consolidation Engines? If so, With What Clearances Should They be Set?*

S. HIGGINS,
W. H. THOMAS,
WM. GARSTANG.

7.—*Best Form of Fire Box to Prevent Cracking. Is it Advisable to Use One Piece for Crown and Side Sheets?*

H. MONKHOUSE,
T. R. BROWNE,
B. HASKELL.

8.—*The Use of Nickel Steel in Locomotive Construction—Its Advantages and Proper Proportion of Nickel.*

A. E. MITCHELL,
PULASKI LEEDS,
TRACY LYON.

9.—*Subjects.*

R. ATKINSON,
JOHN HICKEY,
G. R. HENDERSON.

# CONSTITUTION AND BY-LAWS.

## ARTICLE I.

### NAME.

The name of this Association shall be the "American Railway Master Mechanics' Association."

## ARTICLE II.

### OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is intrusted to their care.

## ARTICLE III.

### MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association, on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the Constitution and By-Laws, or authorizing the Secretary to sign the Constitution for them:

(1) Those above the rank of general foreman, having charge of the design, construction or repair of railway rolling stock.

(2) General foremen, if their names are presented by their superior officers.

(3) Two representatives from each locomotive and car-building works.

SEC. 2. Civil and mechanical engineers, or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling stock as would be of special value to the Association or railroad companies, may become associate members on being recommended by three active members. The name of such candidate shall then be referred to a committee, to be appointed by the President, which shall investigate the fitness of the candidate, and report to the Executive Committee of the Association at the next annual meeting. If the report be unanimous in favor of the candidate the name shall be submitted to ballot, and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting.

SEC. 3. All members of the Association, excepting as hereafter provided, shall be subject to the payment of such annual dues as it may be necessary to assess for

the purpose of defraying the expenses of the Association, provided that no assessment shall exceed $5 a year.

Such dues shall be payable when the amount thereof is announced by the President, at each annual meeting. Any member who shall be two years in arrears for annual dues, shall be notified of the fact, and if the arrears are not paid within three months after such notification, his name shall be taken from the roll and he be duly notified of the same by the Secretary.

SEC. 4. Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered, or he becomes disqualified by the terms of this Constitution. Members whose names have been dropped for non-payment of dues may be restored to membership by the unanimous consent of the Executive Committee on the payment of all back dues.

SEC. 5. Members of the Association who have been in good standing for not less than five years, and who through age or other cause cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at the annual meeting, be elected honorary members. The dues of the honorary members shall be remitted, and they shall have all the privileges of active members, except that of voting.

SEC. 6. Any member who, during the meetings of the Association, shall be guilty of dishonorable conduct which is disgraceful to a railroad officer and a member of the Association, or shall refuse to obey the Chairman when called to order, may be expelled by a two-thirds affirmative vote at any regular meeting of the Association held within one year from the date of the offense.

## ARTICLE IV.

### OFFICERS.

SECTION 1. The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Third Vice-President, a Treasurer, and a Secretary; and they, with the exception of the Secretary, shall constitute the Executive Committee of the Association.

## ARTICLE V.

### DUTIES OF OFFICERS.

SECTION 1. It shall be the duty of the President to preside at all the meetings of the Association, appoint all committees—designating the chairman— and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore.*

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members, and the name of the railway they each represent; to certify to the persons who are eligible as candidates for the Association's scholarships at the Stevens Institute of Technology; to receive and keep an account of all money paid to the Association and deliver the same to the Treasurer,

taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having approval of the President; to deliver all bills paid to the Secretary at the close of each meeting, taking a receipted statement of the same, and to keep an accurate book account of all transactions pertaining to his office.

## ARTICLE VI.

### EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable or any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, but not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

SEC. 2. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawings shall be submitted to each convention and what portion shall be printed in the annual report.

SEC. 3. Three members shall constitute a quorum for the transaction of business.

SEC. 4. The Executive Committee shall form with a committee of the Master Car Builders' Association a Joint Committee to decide on the place of meeting for the annual convention.

## ARTICLE VII.

### ASSOCIATION SCHOLARSHIPS.

It shall be the duty of the Secretary to issue a circular annually intimating the date and place when and where candidates may be examined for the scholarships of the Association in the Stevens Institute of Technology, Hoboken, New Jersey.

Acceptable candidates for the scholarship shall be, first, sons of members or of deceased members of the Association. If there is not a sufficient number of such applicants for the June examination, then applications will be received from other railroad employes or the sons of other railroad employes for the Fall examination. The Secretary shall issue a proper circular in this case as before. In extending the privilege outside of the families of members, preference shall be given to employes or the sons of employes, or the sons of deceased employes of the mechanical departments.

Candidates for these scholarships shall apply to the Secretary of this Association, and if found eligible shall be given a certificate to that effect for presentation to the school authorities. This will entitle the candidate to attend the preliminary examination. If more than one candidate passes the preliminary examination, the appli-

cant passing the highest examination shall be entitled to the scholarship, the school authorities settling the question.

The successful candidate shall be required to take the course of mechanical engineering.

## ARTICLE VIII.

### ELECTION OF OFFICERS.

SECTION 1. The officers of the Association, except the Secretary as hereinafter provided, shall be elected by ballot separately without nomination at the regular meeting of the Association, held in June of each year. A majority of all votes cast shall be necessary to an election, and elections shall not be postponed.

SEC. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

SEC. 3. A Secretary from among the members of the Association shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by vote of the majority of the Executive Committee. He shall also act as Secretary of the Executive Committee.

## ARTICLE IX.

### AUDITING COMMITTEE.

SECTION 1. At the first session of the annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

### COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as hereinafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suitable ones for discussion, and if so, they shall so report them to the Association.

### COMMITTEES ON INVESTIGATION.

SEC. 3. When the Committee on Subjects has reported, and the Association approved of subjects for investigation, the President shall appoint special committees

to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve.

### ARTICLE X.

#### AMENDMENTS.

SECTION 1. This Constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

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# BY-LAWS.

#### TIME OF MEETING.

I. The regular meeting of the Association shall be held annually on the third Tuesday in June.

#### HOURS OF SESSION.

II. The regular hours of session shall be from 9 o'clock A.M. to 2 o'clock P.M.

#### PLACE OF MEETING.

III. Places for holding the Annual Convention shall be selected by a Joint Committee composed of the President, three Vice-Presidents and Treasurer of this Association, and the President, three Vice-Presidents and Secretary of the Master Car Builders' Association. This Joint Committee shall meet within six months after the convention and decide upon a place of meeting, the place receiving the largest number of votes to be selected.

#### QUORUM.

IV. At any regular meeting of the Association, fifteen or more members entitled to vote shall constitute a quorum.

#### ORDER OF BUSINESS.

V. The business of the meetings of this Association shall, unless otherwise ordered by a vote, proceed in the following order:

1. Opening prayer.
2. Address by the President.
3. Acting on the minutes of the last meeting.
4. Reports of Secretary and Treasurer.
5. Assessment and announcement of annual dues.
6. Election of Auditing Committee.

7. Unfinished business.
8. New business.
9. Reports of committees.
10. Reading of papers and discussion of questions propounded by members.
11. Routine and miscellaneous business.
12. Election of officers.
13. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock M. to 1 P.M. of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association, unless otherwise provided.

DISCUSSIONS.

VII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak, and have not been heard, have spoken.

# NAMES AND ADDRESSES OF MEMBERS.

## ACTIVE MEMBERS.

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1896 | Adams, Abraham | Great Northern | Wilmar, Minn. |
| 1896 | Adams, T. E. | Great Northern | Melrose, Minn. |
| 1888 | Addis, J. W | Texas & Pacific | Marshall, Tex. |
| 1895 | Aiken, C. L | Boston & Maine | Springfield, Mass. |
| 1887 | Aldcorn, Thos | | New Durham, N. J. |
| 1892 | Allen, G. S | Philadelphia & Read'g | Tamaqua, Pa. |
| 1894 | Allin, Richard | Arkansas Midland | Helena, Ark. |
| 1895 | Amann, W. E. | | 1536 St. Charles st., Alameda, Cal. |
| 1892 | Antz, Oscar | L. S. & M. S | Cleveland, Ohio. |
| 1887 | Arp, W. C. | T. H. & I | Terre Haute, Ind. |
| 1890 | Atkinson, R | Canadian Pacific | Montreal, Que. |
| 1896 | Atterbury, W. W | Pennsylvania | Altoona, Pa. |
| 1887 | Augustus, W. | Keokuk & Western | Centerville, Iowa. |
| 1886 | Austin, W. L. | Baldwin Loco. Works | Philadelphia, Pa. |
| | | | |
| 1896 | Babcock, C. M | Texas & Pacific | Gouldsboro, La. |
| 1898 | Baker, C. F | Boston Elevated | Boston, Mass. |
| 1894 | Balkam, S. T. | | Calle Teatro No. 17, Monterey, N. L., Mexico. |
| 1889 | Ball, A. W | Erie | Galion, Ohio. |
| 1896 | Bancroft, P. T. | C. S. & H. | Columbus, Ohio. |
| 1898 | Barhydt, J. A. | Buff. Roch. & Pitts. | Rochester, N. Y. |
| 1894 | Barnes, Chas. H. | Boston & Albany | Boston, Mass. |
| 1888 | Barnes, J. B. | Wabash | Springfield, Ill. |
| 1877 | Barnett, J. Davis | Grand Trunk | Stratford, Ont. |
| 1890 | Barnum, M. K. | Union Pacific | Box 68, North Platte, Neb. |
| 1890 | Barr, J. N. | C. M. & St. P | Milwaukee, Wis. |
| 1896 | Barrow, A. R. | Northwestern | Lahore, India. |
| 1895 | Bartlett, Henry | Boston & Maine | Boston, Mass. |
| 1889 | Battye, John E. | Norfolk & Western | Shenandoah, Va. |
| 1895 | Bay, J. P. | Union Pacific | Laramie, Wyo. |
| 1885 | Bean, John | Clev. Canton & South'n | Canton, Ohio. |
| 1889 | Bean, S. L | Northern Pacific | Brainerd, Minn. |
| 1892 | Beattie, A. L. | New Zealand Govt. | Addington, N. Z. |
| 1894 | Beaumont, J. G. | Southern R'ys of Peru | Arequipa, Peru. |
| 1892 | Bechhold, H. G. | Cleveland Frog & Crossing Co. | Cleveland, Ohio. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1885 | Beckert, Andrew | Louisville & Nashville | Decatur, Ala. |
| 1896 | Belcher, A. W | Ulster & Delaware | Rondout, N. Y. |
| 1892 | Beltz, A. J | Del. Sus. & Schuylkill | Drifton, Pa. |
| 1892 | Benson, A. E | Ulster & Delaware | Rondout, N. Y. |
| 1891 | Berry, J. H | C. N. O. & T. P. | Oakdale, Tenn. |
| 1892 | Billingham, Jos | Baltimore & Ohio | Glenwood Shops, Pittsburgh, Pa. |
| 1879 | Bisset, John | W. C. & A | Wilmington, N. C. |
| 1872 | Blackall, R. C | Delaware & Hudson | Albany, N. Y. |
| 1883 | Blackwell, Chas | | 4400 St. Catharine st., Montreal. Can. |
| 1869 | Boon, J. M | | 5117 Madison ave., Chicago, Ill. |
| 1893 | Bond, I | Erie | Susquehanna, Pa. |
| 1896 | Bouchard, E. J | Mo. Kan. & Texas | Parsons, Kan. |
| 1897 | Bowles, C. K | Farmville & Powhatan | Chester, Va. |
| 1890 | Boyle, Wilson L | N. Y. Sus. & Western | Jersey City, N. J. |
| 1895 | Bradeen, A. A | L. S. & M. S | Cleveland, Ohio. |
| 1895 | Bradeen, J. O | L. S. & M. S | Norwalk, Ohio. |
| 1888 | Bradley, W. F | Ann Arbor | Durand, Mich. |
| 1894 | Branch, Geo. E | Brooklyn Wharf & Warehouse Terminal | Brooklyn, N. Y. |
| 1896 | Brangs, P. H | D. L. & W | Hoboken, N. J. |
| 1893 | Brantner, Z. T | Baltimore & Ohio | Brunswick, Md. |
| 1892 | Brehm, W. H | Mo. Kan. & Texas | Parsons, Kan. |
| 1897 | Briggs, D. D | Louisville & Nashville | New Orleans, La. |
| 1879 | Briggs, R. H | K. C. M. & B | Memphis, Tenn. |
| 1898 | Bronner, E. D | Michigan Central | Detroit, Mich. |
| 1887 | Brooke, Geo. D | St. Paul & Duluth | Gladstone, Minn. |
| 1890 | Brown, Angus | Wisconsin Central | Waukesha, Wis. |
| 1892 | Brown, David | D. L. & W | Scranton, Pa. |
| 1887 | Brown, F. R. F | Intercolonial | Moncton, N. B. |
| 1891 | Brown, J. L | | Water Works, Allegheny, Pa. |
| 1896 | Brown, M. D | Mo. Kan. & Texas | New Franklin, Mo. |
| 1891 | Brown, W. A | Buffa. & Susquehanna | Galeton, Pa. |
| 1895 | Browne, T. R | Pennsylvania | Altoona, Pa. |
| 1882 | Brownell, F. G | | Muncie st., Muncie, Ind. |
| 1891 | Bruce, Frank | Montana Central | Great Falls, Mont. |
| 1897 | Bruce, Geo. A | | 526 Cedar st., St. Paul, Minn. |
| 1890 | Bruck, Henry T | Cumb. & Penna | Mt. Savage, Md. |
| 1882 | Bryan, H. S | Duluth & Iron Range | Two Harbors, Minn. |
| 1887 | Buchanan, Wm | N. Y. C. & H. R | New York City. |
| 1896 | Buck, Geo. W | Great Northern | St. Paul, Minn. |
| 1893 | Buckalew, J. H | Mem. & Charleston | Memphis, Tenn. |
| 1891 | Burns, C. H | Hous. & Tex. Central | Houston, Tex. |
| 1893 | Bush, S. P | P. C. C. & St. L | Columbus, Ohio. |
| 1870 | Bushnell, R. W | B. C. R. & N | Cedar Rapids, Iowa. |
| 1893 | Butcher, Geo. W | San Antonio & A. Pass | San Antonio, Tex. |
| 1861 | Butler, L. M | N. Y. P. & B | Providence, R. I. |
| 1890 | Butterly, T. E | Wabash | Moberly, Mo. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1896 | Callander, R. J | | Pernambuco, Brazil, S. A. |
| 1883 | Campbell, John | Lehigh Valley | Buffalo, N. Y. |
| 1891 | Campbell, John D | | 657 Quincy ave., Scranton, Pa. |
| 1896 | Cannon, T. E | Great Northern | Barnesville, Minn. |
| 1889 | Carmody, T | | Cleveland, Ohio. |
| 1896 | Carr, Jas | St. L. I. M. & S | Van Buren, Ark. |
| 1885 | Carson, M. T | Mobile & Ohio | Mobile, Ala. |
| 1889 | Casanave, F. D | Pennsylvania | Altoona, Pa. |
| 1890 | Casey, J. J | Haskell & Barker | Michigan City, Ind. |
| 1892 | Chamberlin, E | | 757 Prospect ave., Buffalo, N. Y. |
| 1893 | Chambers, Jno. S | | 5950 Princeton ave., Chicago. |
| 1878 | Chapman, T. L | Southern R'y | Washington, D. C. |
| 1897 | Chase, F. A | Hannibal & St. Joseph | St. Joseph, Mo. |
| 1893 | Childs, H. A | Erie | Jersey City, N. J. |
| 1895 | Chipman, H. E | Oregon Pacific | Yaquina, Ore. |
| 1898 | Christopher, J | Toronto, Hamilton & Buffalo | Hamilton, Ont., Can. |
| 1896 | Chubb, Thos. L | Buenos Ayres W | La Plata, Ar. Rep., S. A. |
| 1870 | Clark, David | | Hazelton, Pa. |
| 1886 | Clark, Isaac W | C. F. & Y. V | Fayetteville, N. C. |
| 1897 | Clarke, Owen | Texas & Pacific | Marshall, Tex. |
| 1803 | Cleaver, F. C | L. E. & St. L. Con | Princeton, Ind. |
| 1892 | Clifford, C. J | C. L. S. & E | South Chicago, Ill. |
| 1887 | Clifford, J. G | | Tenth and Kentucky sts., Louisville, Ky. |
| 1887 | Cloud, John W | | Rookery Bldg., Chicago, Ill. |
| 1896 | Coale, J. M | Northern Central | Baltimore, Md. |
| 1895 | Cockfield, Jos | Chicago & North-Western | Clinton, Iowa. |
| 1891 | Cockfield, Wm | Mexican Central | Chihuahua, Mex. |
| 1896 | Cole, F. J | | Rogers Locomotive Works, Paterson, N. J. |
| 1891 | Collinson, Jas | G. C. & S. F | Galveston, Tex. |
| 1890 | Conolly, J. J | D. S. S. & A | Marquette, Mich. |
| 1892 | Conroe, I | A. T. & S. F | Newton, Kan. |
| 1879 | Cook, John S | Georgia | Augusta, Ga. |
| 1879 | Cooke, Allen | | Danville, Ill. |
| 1891 | Cooke, W. I | Chicago & Eastern Ill | Momence, Ill. |
| 1898 | Cooper, C. J | Toledo & Ohio Central | Kenton, Ohio. |
| 1876 | Cory, C. H | C. H. & D | Lima, Ohio. |
| 1892 | Crawford, S. B | Balto. & Ohio | Parkersburg, W. Va. |
| 1885 | Cromwell, A. J | | 1411 Hollins st., Baltimore, Md. |
| 1893 | Cross, W | Canadian Pacific | Winnipeg, Man. |
| 1883 | Cullen, Jas | N. C. & St. L | Nashville, Tenn. |
| 1896 | Cullinan, J | Norfolk & Western | Portsmouth, Ohio. |
| 1872 | Cushing, G. W | | Evanston, Ill. |
| | | | |
| 1888 | Dallas, Wilber C | Galena Oil Co | Franklin, Pa. |
| 1890 | Davies, J. M | | 56 Broad st., Plattsburgh, N. Y. |
| 1892 | Davis, Ed E | Phila. & Reading | Reading, Pa. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1893 | Davis, Wm. J | Pitts. & Western | Foxbury, Pa. |
| 1897 | Dawson, E | K. C. P. & G | Pittsburg, Kan. |
| 1894 | Deeble, Wm. R | Tasmania Govt | Strahan, Tasmania. |
| 1891 | Deems, J. F | C. B. & Q | West Burlington, Iowa. |
| 1896 | De Gress, C | | Mex. Nat. Construc. Co., Colima, Mex. |
| 1897 | De Haven, C. A | Kansas Midland | Wichita, Kan. |
| 1892 | Dehn, F. H | | Walnut Springs, Texas. |
| 1897 | Delaney, C. A | | Supt. Richmond Loco. Works, Richmond, Va. |
| 1895 | Delaney, H | Phila. & Reading | Philadelphia, Pa. |
| 1894 | De Witt, Chas. H | Lehigh Valley | Delano, Pa. |
| 1896 | Dickerson, S. K | Norfolk & Western | East Radford, Va. |
| 1887 | Dickson, G. L | | Dickson Loco. Works, Scranton, Pa. |
| 1894 | Dixon, W. F | | Sormovo Co., Philadelphia, Pa. |
| 1897 | Doebler, C. H | Wabash | Ft. Wayne, Ind. |
| 1898 | Dolan, S. M | E. St. Louis Conn. & Transfer | East St. Louis, Ill. |
| 1890 | Dolbeer, Alonza | | 99 Lexington ave., Rochester, N. Y. |
| 1896 | Donahue, Geo | Erie | Meadville, Pa. |
| 1880 | Dotterer, D. H | | 45 Wellington ave., Rochester, N. Y. |
| 1893 | Dow, Jas. M | Tol. & Ohio Central | Kenton, Ohio. |
| 1890 | Downing, T | | Station E, Minneapolis, Minn. |
| 1896 | Driscoll, J. L | Catskill Mountain | Catskill, N. Y. |
| 1893 | Drury, Michael J | A. T. & S. F | Arkansas City, Kan. |
| 1894 | Duncan, T. G | | Chillicothe, Ohio. |
| 1896 | Dunn, J. F | Oregon Short Line | Salt Lake City, Utah. |
| | | | |
| 1869 | Elliott, Henry | | East St. Louis, Ill. |
| 1895 | Ellis, John | Maine Central | Waterville, Me. |
| 1893 | Ellis, John J | C. St. P. M. & O | St. Paul, Minn. |
| 1897 | Elvin, A. G | Ches. & Ohio | Huntington, W. Va. |
| 1893 | English, H. W | | Birmingham R'y & Elec. Co., Birmingham, Ala. |
| 1893 | English, Richard | Santa Fe Pacific | Albuquerque, N. M. |
| 1881 | Ennis, W. C | N. Y. S. & W | North Paterson, N. J. |
| 1898 | Erskine, A. S | Wiscasset & Quebec | Wiscasset, Me. |
| 1892 | Esson, R. C | Southern Pacific | Newark, Cal. |
| 1898 | Ettinger, R. L | C. C. C. & St. L | Indianapolis, Ind. |
| | | | |
| 1885 | Fenwick, A | | Fort Howard, Wis. |
| 1885 | Ferguson, G. A | | 48 Staniford st., Boston, Mass. |
| 1896 | Fisher, G. P | Mo. Kan. & Texas | Terrell, Texas. |
| 1892 | Fitzmorris, Jas | Chicago Junction | Union Stock Yards, Chicago, Ill. |
| 1895 | Foller, P. P | W. N. Y. & Pa | Oil City, Pa. |
| 1896 | Foque, T. A | M. St. P. & S. Ste. M | Minneapolis, Minn. |
| 1888 | Forsyth, Wm | C. B. & Q | Aurora, Ill. |
| 1875 | Foster, W. A | Fall Brook R'y Co | Corning, N. Y. |
| 1890 | Foulk, John | Jacksonville & St. Louis | Jacksonville, Ill. |
| 1877 | Fowle, I. W | | Riverside, Cal. |
| 1887 | Fraser, T. A | | Wells & French Car Works, Chicago, Ill. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1891 | French, R. E | Southern Pacific | Kern, Cal. |
| 1898 | Frey, N | Chgo. Bur. & Northern | LaCrosse, Wis. |
| 1890 | Fuller, C. E | Central Vermont | St. Albans, Vt. |
| 1872 | Fuller, Wm | | 213 Kennard st, Cleveland, Ohio. |
| | | | |
| 1893 | Gage, George W | St. L. S.-W | Pine Bluff, Ark. |
| 1897 | Gaines, F. F | Lehigh Valley | South Easton, Pa. |
| 1891 | Galbraith, R. M | St. L. S.-W | Pine Bluff, Ark. |
| 1897 | Gardner, A | C. & C. V | Cooperstown, N. Y. |
| 1893 | Garrick, J. R | Tex. & New Orleans | Beaumont, Tex. |
| 1892 | Garrison, P. E | Fonda, Johnstown & Gloversville | Gloversville, N. Y. |
| 1887 | Garstang, Wm | C. C. C. & St. L | Indianapolis, Ind. |
| 1886 | Gentry, T. W | Richmond Loco. Wks | Richmond, Va. |
| 1888 | Gibbs, A. W | Pennsylvania | Altoona, Pa. |
| 1890 | Gibbs, George | Baldwin Loco. Wks | Philadelphia, Pa. |
| 1896 | Gill, Jno | C. R. I. & P | Horton, Kan. |
| 1891 | Gillis, H. A | Richmond Loco. Wks | Richmond, Va. |
| 1883 | Gilmore, W. L | L. S. & M. S | Elkhart, Ind. |
| 1893 | Gilmour, George | N. Y. Telephone Co | 15 Dey st., New York. |
| 1890 | Givan, F. A | B. St. M. & S.-W | St. Mary's, Pa. |
| 1897 | Glaser, J | Cleveland & Marietta | Cambridge, Ohio. |
| 1891 | Glass, John C | Allegheny Valley | Verona, Pa. |
| 1891 | Glover, J. B | Mar. & N. Georgia | Marietta, Ga. |
| 1880 | Gordon, H. D | | 71 John st., New York. |
| 1879 | Gordon, James T | Concord | Concord, N. H. |
| 1892 | Graham, Charles, Jr | D. L. & W | Kingston, Pa. |
| 1894 | Graham, J. A | Clev. Lorain & W | Lorain, Ohio. |
| 1894 | Grant, A. S | H. E. & W. T | Houston, Tex. |
| 1892 | Gray, Robert | Southern Pacific | Tucson, Ariz. |
| 1889 | Greatsinger, J. L | D. & I. Range | Duluth, Minn. |
| 1897 | Greaven, Luis | Western R'y of B. A | Caballito, Buenos Ayres, Arg. Rep., S. A. |
| 1895 | Green, Wilbur | S. A. & A. P | Yoakum, Tex. |
| 1896 | Greenwood, Alfred W | East Broad Top | Rockhill Furnace, Pa. |
| 1895 | Gregory, Geo | Chicago Great Western | Oelwein, Iowa. |
| 1891 | Griffin, B. F | Duluth, Miss. R. & N | Swan River, Minn. |
| 1885 | Griffith, Fred B | D. L. & W | Buffalo, N. Y. |
| 1893 | Gross, R. J | | Brooks Loco. Works, Dunkirk, N. Y. |
| 1896 | Groves, J. R | St. L. & S. F | Springfield, Mo. |
| | | | |
| 1880 | Hackney, Clem | | Fox Solid Pressed Steel Co., Joliet, Ill. |
| 1875 | Haggett, J. C | | Dunkirk, N. Y. |
| 1886 | Haggerty, G. A. | | Southbridge, Mass. |
| 1893 | Hainen, J | Erie | Port Jervis, N. Y. |
| 1898 | Hair, John | Balto. & Ohio S.-W | Chillicothe, Ohio. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1896 | Hall, J. W. | St. L. S.-W. | Commerce, Tex. |
| 1891 | Hancock, Geo. A. | A. T. & S. F. | Topeka, Kan. |
| 1893 | Hancock, Wm. S. | A. & Pacific | Needles, Cal. |
| 1896 | Hanglin, J. A. | Hot Springs | Malvern, Ark. |
| 1893 | Hardie, Jas. | | Hardie & Co., Valparaiso, Chil. |
| 1896 | Harrison, Jno. | San Paulo | San Paulo, Brazil, S. A. |
| 1898 | Harrison, F. J. | Buffa., Roch. & Pittsburg. | Rochester, N. Y. |
| 1885 | Harrison, W. H. | Balto. & Ohio | Newark, Ohio. |
| 1889 | Haskell, B. | Chic. & W. Mich. | Grand Rapids, Mich. |
| 1888 | Hassman, Wm. | Illinois Central | Paducah, Ky. |
| 1875 | Hatswell, T. J. | F. & P. M. | Saginaw, E. S., Mich. |
| 1897 | Hatswell, T. J., Jr. | F. & P. M. | Saginaw, E. S., Mich. |
| 1895 | Hawksworth, D. | B. & M. River | Plattsmouth, Neb. |
| 1896 | Hayward, H. S. | Pennsylvania | Jersey City, N. J. |
| 1891 | Hedley, E. M. | C. R. of N. J. | Elizabethport, N. J. |
| 1891 | Hedley, F. | Lake Street Elevated | Chicago, Ill. |
| 1896 | Heers, L. B. | C. N. Y. & W. R. R. | Angelica, N. Y. |
| 1887 | Heintzleman, T. W. | Southern Pacific | Sacramento, Cal. |
| 1888 | Hemphill, W. J | St. L. Peoria & North'n. | Springfield, Ill. |
| 1886 | Hendee, A. | Westinghouse Air Brake Co. | Wilmerding, Pa. |
| 1892 | Henderson, G. R. | Norfolk & Western | Roanoke, Va. |
| 1897 | Hennessey, T. J. | Michigan Central | Jackson, Mich. |
| 1897 | Hepburn, G. W. | Ches. & Ohio | Hinton, W. Va. |
| 1898 | Herbert, R. L. | Gulf, West'n Tex. & Pac.<br>N. Y., Texas & Mexican. | Victoria, Tex. |
| 1892 | Herr, Edwin M. | Northern Pacific | St. Paul, Minn. |
| 1871 | Hewitt, John | | 1323 So. Jefferson st., St. Louis, Mo. |
| 1895 | Hibbard, H. Wade | Cornell University | Ithaca, N. Y. |
| 1883 | Hickey, John | Rio Grande Western | Salt Lake City, Utah. |
| 1890 | Higgins, S. | Lehigh Valley | S. Bethlehem, Pa. |
| 1887 | Hill, Jas. W. | P. & Pekin Union | Peoria, Ill. |
| 1892 | Hill, Rufus | Pennsylvania | Pavonia, N. J. |
| 1897 | Hinchey, Jas. | Cent. Vermont | New London, Conn. |
| 1892 | Hinckley, A. C. | St. Jo. & Gr. Island | St. Joseph, Mo. |
| 1885 | Hinman, M. L. | | Brooks Loco. Works, Dunkirk, N. Y. |
| 1894 | Hiser, Edwin C. | | Lockport, N. Y. |
| 1883 | Hoffecker, W. L. | Central of N. J. | Elizabethport, N. J. |
| 1896 | Hogsett, C. E. | Moctezuma Copper Co. | Bisbee, Arizona. |
| 1892 | Holland, W. D. | Southern Pacific | Tracy, Cal. |
| 1885 | Holman, W. L. | Pennsylvania | Renovo, Pa. |
| 1890 | Homer, John C. | Cin. P. & Virginia | Portsmouth, Ohio. |
| 1896 | Hopwood, Jno. | Argentine Gt. West. | Mendoza, Argentine Rep., S. A. |
| 1896 | Horrigan, Jno. | E. J. & E. R. R. | Joliet, Ill. |
| 1892 | Howard, C. H. | | Union Trust Bldg., St. Louis, Mo. |
| 1896 | Howard, Jno. | West Shore | New Durham, N. J. |
| 1890 | Hudson, E. E. | C. C. C. & St. L. | Bellefontaine, Ohio. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1892 | Hudson, W. H. | Southern | Spencer, N. C. |
| 1890 | Hufsmith, F. | I. & G. N. | Palestine, Tex. |
| 1890 | Humphrey, A. L | Colorado Mid. | Colorado City, Colo. |
| 1895 | Hutchinson, Wm. | C. & North-Western. | Eagle Grove, Iowa. |
| 1896 | Hyndman, F. T. | Pitts. & Western R'y. | Allegheny, Pa. |
| 1896 | Inge, T. S. | Southern | Columbia, S. C. |
| 1888 | Jackson, O. H | S. F. P. & P. | Prescott, Ariz. |
| 1896 | James, Geo. | N. Y. C. & St. L. | Stony Island, Ill. |
| 1890 | Jennings, Wm. | Mexican International. | Ciudad Porfirio, Diaz, Mex. |
| 1893 | Jerome, E. W. | | 557 Second st., Albany, N. Y. |
| 1896 | Johnson, A. B. | | Baldwin Loco. Works, Philadelphia, Pa. |
| 1878 | Johnson, J. B. | Arkansas Midland | Helena, Ark. |
| 1887 | Johnson, L. R. | Canadian Pacific | Vancouver, B. C. |
| 1898 | Johnson, R. H. | Atlanta & West Point. Western of Alabama. | Montgomery, Ala. |
| 1887 | Johnstone, F. W. | Mexican Central | City of Mexico, Mex. |
| 1888 | Joughins, G. R. | Intercolonial | Moncton, N. B., Can. |
| 1896 | Justice, D. J. | Atlantic Coast Line. | Florence, S. C. |
| 1890 | Kalbaugh, I. N. | Balto. & Ohio. | Baltimore, Md. |
| 1896 | Keegan, Jas. A. | C. C. C. & St. L | Riverside, Cincinnati, Ohio. |
| 1892 | Keegan, Jas. E. | G. R. & Ind. | Grand Rapids, Mich. |
| 1890 | Keith, J. M. | W. R'y of Gautemala | San Filipe, Gautemala, C. A. |
| 1896 | Kells, Willard. | Chicago & Erie. | Huntington, Ind. |
| 1896 | Kelly, Wm. | Great Northern. | Hillyard, Wash. |
| 1894 | Kennedy, Jas | Jamaica | Kingston, Jamaica. |
| 1893 | Kenney, Geo. W. | Central Vermont | Rutland, Vt. |
| 1890 | Killen, W. E. | St. Louis & Peoria Line. | Springfield, Ill. |
| 1898 | King, D. M. | Raleigh & Gaston | Raleigh, N. C. |
| 1892 | Kirk, John | A. T. & S. F. | Arkansas City, Kan. |
| 1892 | Kistler, Lewis. | D. L. & W. | Syracuse, N. Y. |
| 1896 | Knapp, E. W. | Toluca & Tenango. | Toluca, Mexico. |
| 1890 | Knapp, G. | Humeston & Shenandoah | Shenandoah, Iowa. |
| 1898 | Laing, W | Texas & Pacific. | Texarkana, Tex. |
| 1898 | Lake, E. M. | Gulf & Ship Island | Gulfport, Miss. |
| 1895 | La Lime, E | Ohio River. | Parkersburg, W. Va. |
| 1896 | Lamplugh, Q. | Colo. & N.-W. | Boulder, Colo. |
| 1894 | Lang, V. B. | Cin., N. O. & Tex. Pac. | Chattanooga, Tenn. |
| 1888 | Lape, C. F | So. Cal. | San Bernardino, Cal. |
| 1895 | Lauer, F. G. | B. R. & Pittsburgh. | Du Bois, Pa. |
| 1889 | Lavery, W. | Erie | Cleveland, Ohio. |
| 1891 | Lawler, F. M | C. C. C. & St. L. | Brightwood, Ind. |
| 1891 | Lawes, T. A | C. & E. I | Danville, Ill. |
| 1896 | Lawrence, J. L. | Cumb. Valley. | Chambersburg, Pa. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1890 | Leach, H. L. | | Room 45, Mason Bldg., Boston, Mass. |
| 1892 | Lee, C. W. | Southern | Salisbury, N. C. |
| 1896 | Leech, C. C | | 88½ Putnam st., Buffalo, N. Y. |
| 1883 | Leeds, Pulaski | Louisville & Nashville | Louisville, Ky. |
| 1888 | Leigh, F. J | | Can. Loco. Works, Kingston, Ont. |
| 1890 | Leonard, A. G | N. Y. Central | New York City. |
| 1873 | Lewis, W. H | D. L. & W | Kingsland, N. J. |
| 1876 | Lewis, W. H | Norfolk & Western | Roanoke, Va. |
| 1896 | Lindoff, Geo | Montana Union | Anaconda, Mont. |
| 1896 | Linstrom, Chas | Yazoo & Miss. Valley | Vicksburg, Miss. |
| 1890 | Lloyd, T. S | Ches. & Ohio | Richmond, Va. |
| 1890 | Logan, P. A | Can. Eastern | Gibson, N. B. |
| 1895 | Lonergan, P. T | R. W. & O | Oswego, N. Y. |
| 1868 | Losey, Jacob | | Louisville Steam Forge Co., Louisville, Ky. |
| 1897 | Lucas, W. O | Central Argentine | Rosario, Arg. Rep., S. A. |
| 1890 | Luttgens, H. A | | L. B. 639, Paterson, N. J. |
| 1894 | Lyon, Tracy | Chic. Gt. Western | St. Paul, Minn. |
| 1885 | Lythgoe, Joseph | | R. I. Loco. Works, Providence, R. I. |
| | | | |
| 1887 | Macbeth, Jas | N. Y. Central | Buffalo, N. Y. |
| 1892 | Macdonald, Aug. V | New Zealand R'ys | Newmarket, Auckland, N. Z. |
| 1890 | Macfarlane, T. W | | Assumption, Ill. |
| 1876 | Mackenzie, John | N. Y. C. & St. L | Cleveland, Ohio. |
| 1892 | Mackinnon, Geo. S | Canadian Pacific | Toronto Junction, Ont. |
| 1896 | Maher, P | Ind. Ill. & Iowa | Kankakee, Ill. |
| 1896 | Mahl, F. W | So. Pac | Sacramento, Cal. |
| 1895 | Mallinson, E. P | Brooklyn Elevated | 2075 B'way, Brooklyn, N. Y. |
| 1894 | Manchester, A. E | C. M. & St. P. R'y | Milwaukee, Wis. |
| 1893 | Manning, J. H | Union Pacific | Omaha, Neb. |
| 1898 | Marchbanks, James | Wellington & Manawatu | Wellington, N. Z. |
| 1896 | Marden, J. W | Fitchburg | Boston, Mass. |
| 1897 | Marshall, B. F | Clev. Ak. & Columbus | Mt. Vernon, Ohio. |
| 1890 | Marshall, E. S | Manager Western R'y Equipment Co | St. Louis, Mo. |
| 1891 | Marshall, W. H | C. & N.-W | Chicago, Ill. |
| 1896 | Martin, F. P | | |
| 1888 | Maver, A. A | Grand Trunk | Stratford, Ont. |
| 1892 | McCann, Thos | Geo. Creek & Cum | Cumberland, Md. |
| 1891 | McConnell, J. H | Union Pacific | Omaha, Neb. |
| 1896 | McCormick, A | Chicago & Alton | Bloomington, Ill. |
| 1890 | McCreery, Frank | C. H. & D | Dayton, Ohio. |
| 1892 | McCuen, J. P | C. N. O. & T. P | Ludlow, Ky. |
| 1891 | McDonough, James | Gulf, Colo. & S. F | Galveston, Tex. |
| 1892 | McDuff, Allan | B. C. R. & N | Cedar Rapids, Iowa. |
| 1893 | McElvaney, C. T | M. K. & Tex | Denison, Tex. |
| 1890 | McIntosh, Wm | Ch. & N.-Western | Winona, Minn. |
| 1893 | McKee, G. S | Wabash | Moberly, Mo. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1896 | McLean, W. J | | 597 High st., New Whatcom, Wash. |
| 1894 | McMasters, Chas. J | Benn. & Rutland | Rutland, Vt. |
| 1896 | McNabb, T | Gt. Falls & Canada | Lethbridge, Alberta, Can. |
| 1890 | McNaughton, Jas | | Brooks Loco. Works, Dunkirk, N. Y. |
| 1896 | McNeill, Wm. D | Hoosac Tun. & Wil. | Readsboro, Vt. |
| 1888 | Medway, John | Fitchburg | Boston, Mass. |
| 1895 | Mellin, C. J | | Richmond Loco. Works, Richmond, Va. |
| 1892 | Mertsheimer, F | K. C. Pittsburg & Gulf. | Kansas City, Mo. |
| 1887 | Michael, J. B | Southern | Knoxville, Tenn. |
| 1883 | Middleton, Harvey | Balto. & Ohio | Baltimore, Md. |
| 1885 | Millen, Thos | G. M. M., Metropolitan Street R'y, 106 W. 51st st., New York. | |
| 1889 | Miller, E. A | N. Y. C. & St. L. | Conneaut, Ohio. |
| 1890 | Miller, Geo. A | Florida East Coast | St. Augustine, Fla. |
| 1896 | Miller, G. W | Erie | Elmira, N. Y. |
| 1898 | Miller, Robt | Michigan Central | Detroit, Mich. |
| 1890 | Mills, Stott | | Warwick, N. Y. |
| 1893 | Minshull, P. H | N. Y. O. & W | Middletown, N. Y. |
| 1892 | Minto, H. M | Louisville & Nashville | Mobile, Ala. |
| 1888 | Minton, A. B | Mobile & Ohio | Murphysboro, Ill. |
| 1892 | Mitchell, Alva | A. T. & S. F | Ottawa, Kan. |
| 1870 | Mitchell, A | Lehigh Valley | Wilkesbarre, Pa. |
| 1892 | Mitchell, A. E | Erie | New York City. |
| 1898 | Moler, A. L | Thompson Smelting & Refining Co., St. Louis, Mo. | |
| 1890 | Monkhouse, H | Chicago & Alton | Bloomington, Ill. |
| 1888 | Montgomery, Wm | Cent. of N. J | Manchester, N. J. |
| 1890 | Moore, J. H | Erie | Buffalo, N. Y. |
| 1895 | Moraga, Anselmo | Chilian State | Santiago, Chili. |
| 1896 | Moran, Robt | Louisville & Nashville | Bowling Green, Ky. |
| 1887 | Morris, W. S | Ches. & Ohio | Richmond, Va. |
| 1890 | Morse, F. W | Grand Trunk | Montreal, Can. |
| 1890 | Murphy, P. H | | Murphy Car Roof Co., East St. Louis, Ill. |
| | | | |
| 1894 | Nettleton, W. A | K. C. Ft. S. & M | Kansas City, Mo. |
| 1898 | Neubert, G. T | Atch., Topeka & S. F. | Arkansas City, Kan. |
| 1892 | Neuffer, John G | B. & O. S.-W | Cincinnati, Ohio. |
| 1896 | New, W. T | Mo. Pac | Kansas City, Mo. |
| 1898 | Newell, T. W. | Atlanta, Kn'xv'e & N'n. | Blue Ridge, Ga. |
| 1896 | Neward, F. H | Pontiac, Ox. & North'n. | Pontiac, Mich. |
| 1896 | Nicholas, J. O | Mexican National | Toluca, Mex. |
| 1890 | Nicholls, J. Mayne | Nitrate R'ys | Iquique, Chili. |
| 1875 | Noble, L. C | A. French Spring Co., | 1414 Fisher Bldg., Chicago. |
| 1896 | Norsworthy, N. W | Norfolk & Western | Crewe, Va. |
| 1896 | Nuttall, W. H | Manistee & N.-Eastern | Manistee, Mich. |
| | | | |
| 1890 | O'Brien, John | Rich. & Petersburg | Manchester, Va. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1890 | O'Herin, Wm | Mo. Kan. & Tex | Parsons, Kan. |
| 1895 | O'Leary, D | Seattle & International | Seattle, Wash. |
| 1895 | Orland, W. P | C. C. C. & St. L. | Mattoon, Ill. |
| 1897 | Osborne, H | Canadian Pacific | Montreal, Can. |
| 1897 | Owens, W. H | Southern | Manchester, Va. |
| | | | |
| 1890 | Page, H. D | Chic. & N.-Western | Baraboo, Wis. |
| 1891 | Pattee, J. O | Great Northern | St. Paul, Minn. |
| 1879 | Patterson, J. S | | Galena Oil Co., Cincinnati, Ohio. |
| 1885 | Paxson, L. B | Phila. & Reading | Reading, Pa. |
| 1891 | Paxton, Thos | A. T. & S. F | Ft. Madison, Iowa. |
| 1897 | Payton, H. T | A. T. & S. F | Raton, N. M. |
| 1897 | Pease, F. J | T. St. L. & K. C | Frankfort, Ind. |
| 1887 | Peck, Peter H | C. W. I. & B | Chicago, Ill. |
| 1897 | Pflager, H. M | | Pullman Palace Car Co., Chicago, Ill. |
| 1889 | Phelan, J. E | | Railroad Commission, Bismarck, N. D. |
| 1878 | Pilsbury, Amos | Maine Central | Waterville, Me. |
| 1885 | Pitkin, A. J | | Schenectady Loco. Works, Schenectady, N. Y. |
| 1874 | Place, T. W | Illinois Central | Waterloo, Iowa. |
| 1881 | Player, John | A. T. & S. F | Topeka, Kan. |
| 1897 | Pollitt, Harry | Great Central | Gorton, Manchester, Eng. |
| 1893 | Potter, G. L | Penn. Lines | Fort Wayne, Ind. |
| 1897 | Potton, J | Texas & Pacific | Big Springs, Tex. |
| 1891 | Prescott, C. H | Spokane Falls & Nor | Spokane Falls, Wash. |
| 1894 | Priest, Edwin | Boston & Albany | East Albany, N. Y. |
| 1881 | Pringle, R. M | | Second and Carr sts., St. Louis, Mo. |
| 1891 | Pullar, John | Santa Fe Pacific | Winslow, Ariz. |
| 1890 | Purves, T. B., Jr | Boston & Albany | Springfield, Mass. |
| | | | |
| 1888 | Quayle, Robert | Chgo. & North-Western | Chicago, Ill. |
| 1895 | Quereau, C. H | Denver & Rio Grande | Denver, Colo. |
| 1888 | Quinn, John A | Ches. & Ohio | Clifton Forge, Va. |
| | | | |
| 1896 | Rainsford, Henry J | Montana Union | Anaconda, Mont. |
| 1890 | Randolph, L. S | | Virginia Polytechnic Institute, Blacksburg, Va. |
| 1892 | Reading, R. B | | Passaic, N. J. |
| 1891 | Rearden, Frank | Missouri Pacific | St. Louis, Mo. |
| 1895 | Redding, M. J | W. & B. R. V | Brinkley, Ark. |
| 1888 | Reed, W. T | Seaboard Air Line | Portsmouth, Va. |
| 1890 | Reid, M. M | Atlantic & Danville | Lawrenceville, Va. |
| 1883 | Renshaw, W | Illinois Central | Chicago, Ill. |
| 1892 | Rettew, C. E | D. & H. C | Carbondale, Pa. |
| 1896 | Reynolds, O. H | Asso. Ed. Loco. Eng | 256 Broadway, N. Y. |
| 1887 | Rhodes, G. W | Chi. Bur. & Quincy | Aurora, Ill. |
| 1896 | Richards, George F | Elmira, Cort. & Noth'n | Cortland, N. Y. |
| 1897 | Rickert, Mason | C. C. C. & St. L | Delaware, Ohio. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1894 | Riley, George N. | McKeesport Connecting. | McKeesport, Pa. |
| 1882 | Roberts, E. M. | South Atlantic & Ohio. | Bristol, Tenn. |
| 1896 | Roberts, J. W. | | 1006 Cornell ave., Indianapolis, Ind. |
| 1891 | Roberts, Mord. | St. L. I. M. & S. | Little Rock, Ark. |
| 1895 | Robinson, Frank. | Maine Central. | Bangor, Maine. |
| 1898 | Robinson, J. T. | Southern R'y. | Selma, Ala. |
| 1896 | Robkin, Charles | Little Rock & Mem. | Argenta, Ark. |
| 1896 | Rogers, M. J. | K. C. Belt. | Kansas City, Mo. |
| 1898 | Romans, G. L. | Coast R'y | Yarmouth, N. S., Canada. |
| 1896 | Rosing, W. H. V. | Illinois Central | Chicago, Ill. |
| 1882 | Ross, George B. | | Box 326, Buffalo, N. Y. |
| 1894 | Roth, Frederick | Lehigh Valley. | Delano, Pa. |
| 1892 | Rotheram, T. F | New Zealand Govt | Wellington, N. Z. |
| 1895 | Royal, C. B. | Seaboard Air Line. | Portsmouth, Va. |
| 1898 | Rumney, T. | Ogdensburg & Lake Champlain, | Malone, N. Y. |
| 1896 | Rusch, Peter C. | Buffalo, Roch. & Pitts. | Bradford, Pa. |
| 1890 | Rutherford, Wm | | Savannah, Ga. |
| 1893 | Ryan, E. | Gal. H. & San. A. | San Antonio, Tex. |
| 1892 | Ryan, Patrick | Louisville & Nashville. | Russellville, Ky. |
| 1891 | Ryan, J. J | Southern Pacific. | Houston, Tex. |
| 1891 | Ryder, Henry. | Housatonic | Falls Village, Conn. |
| | | | |
| 1892 | Sague, J. E. | Schenectady Loco. Works, | Schenectady, N. Y. |
| 1887 | Sample, N. W. | Denver & Rio Grande. | Denver, Colo. |
| 1891 | Sanborn, J. N. | Brainard & No. Minn | Brainard, Minn. |
| 1896 | Sanderson, R. P. C | Norfolk & Western | Roanoke, Va. |
| 1895 | Sandt, E. I | Phila. & Reading. | Philadelphia, Pa. |
| 1896 | Sanford, J. W. | Pennsylvania | Jersey City, N. J. |
| 1896 | Santer, A. | Norfolk & Western | Lambert's Point, Va. |
| 1898 | Schaefer, Hugo. | Phila. Reading & New England, | Hartford, Conn. |
| 1874 | Schlacks, Henry. | Denver & Rio Grande. | Denver, Colo. |
| 1875 | Sedgwick, E. V. | Galena Oil Co. | Franklin, Pa. |
| 1896 | Sehrt, H. M | Ohio Southern | Springfield, Ohio. |
| 1869 | Setchel, J. H | | Cuba, N. Y. |
| 1868 | Shaver, D. O | Pennsylvania. | Pittsburg, Pa. |
| 1891 | Sheer, Jas. M | | 514 Seventh st., East St. Louis, Ill. |
| 1898 | Shields, Alex | Southern Indiana. | Bedford, Ind. |
| 1890 | Shields, J. C. | Mineral Range. | Hancock, Mich. |
| 1898 | Shone, G. H. | Denver & Rio Grande. | Alamosa, Colo. |
| 1883 | Sinclair, Angus. | | 256 Broadway, New York City. |
| 1892 | Sinnott, B | Balto. & Ohio. | Philadelphia, Pa. |
| 1896 | Skinner, Calvin. | Ala. Great Southern. | Birmingham, Ala. |
| 1889 | Skinner, H. M. C. | | 88 Walnut st., Fall River, Mass. |
| 1893 | Slater, Frank. | Chicago & N.-W | Escanaba, Mich. |
| 1889 | Slater, John C. | Nevada Cent. | Battle Mt., Nev. |
| 1894 | Slayton, C. E | Chic. Gr. Western. | Oelwein, Iowa. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1889 | Small, H. J. | Southern Pacific | Sacramento, Cal. |
| 1893 | Smith, F. B. | N. Y. N. H. & H. | New Haven, Conn. |
| 1896 | Smith, F. C. | Fitchburg | Mechanicsville, N. Y. |
| 1890 | Smith, Geo. W | Santa Fe Pacific | Albuquerque, N. M. |
| 1894 | Smith, H. C. | | 117A North Olive st., Los Angeles, Cal. |
| 1892 | Smith, John L. | Buffalo, Roch. & Pitts. | Du Bois, Pa. |
| 1891 | Smith, Wm | Duluth, Missabe & Nor. | Duluth, Minn. |
| 1869 | Smith, W. T | Chesapeake & Ohio | Covington, Ky. |
| 1891 | Soule, R. H. | Baldwin Loco. Wks., | 1217 Monadnock Bldg., Chicago, Ill. |
| 1897 | Spragge, Jos. R. | Can. Pacific | McAdam Junct., N. B. |
| 1868 | Sprague, H. N | | Jamestown, N. Y. |
| 1895 | Sprigg, Z. T | Union Pacific | Denver, Colo. |
| 1895 | Stafford, Jas. T. | St. L. I. M. & South. | Little Rock, Ark. |
| 1893 | Stalder, Abram W | F. Ft. W. & W | Findlay, Ohio. |
| 1890 | Stamelen, F. | Erie & Huron | Chatham, Ont. |
| 1898 | Stansbury, C. M. | Pecos Vall. & N.-East. | Eddy, N. M. |
| 1894 | Steele, S. A. | W. & Pitts | Weston, W. Va. |
| 1874 | Stevens, Geo. W | L. S. & M. S | Cleveland, Ohio. |
| 1892 | Stewart, Andrew F. | Ches. & Ohio | Huntington, W. Va. |
| 1885 | Stewart, O. | Bangor & Aroostook | Oldtown, Maine. |
| 1890 | Stillman, H. | Southern Pacific | Sacramento, Cal. |
| 1896 | Stocks, W. H | C. R. I. & P. | Rock Island, Ill. |
| 1883 | Stokes, J. W. | Detroit & Lima Nor. | Tecumseh, Mich. |
| 1896 | Stout, S. E. | Phila. & Reading | Philadelphia, Pa. |
| 1875 | Strode, Jas | Northern Central | Elmira, N. Y. |
| 1890 | Studer, A. L | C. R. I. & P. | Trenton, Mo. |
| 1891 | Summerskill, T. A | M. & N.-West | Portage la Prairie, Man. |
| 1892 | Sumner, Eben T. | Boston & Maine | East Cambridge, Mass. |
| 1892 | Sutherland, R. D | Boston, R. B. & Lynn | Boston, Mass. |
| 1868 | Swanston, Wm | P. C. C. & St. L. | Indianapolis, Ind. |
| 1892 | Symons, W. E | Plant System | Savannah, Ga. |
| | | | |
| 1894 | Taft, Wm. H. | Boston & Albany | Boston, Mass. |
| 1883 | Tandy, H. | Supt. Canadian Loco. Works, | Kingston, Ont., Can. |
| 1896 | Tawse, Robt | Ann Arbor | Owosso, Mich. |
| 1893 | Taylor, C. M. | A. T. & S. F | Raton, N. M. |
| 1896 | Taylor, Jno | C. M. & St. P. | Minneapolis, Minn. |
| 1893 | Taylor, Wm. H | Wilkesbarre & East. | Stroudsburg, Pa. |
| 1886 | Thatcher, Thos. | D. L. & W. | Utica, N. Y. |
| 1885 | Thomas, C. F. | Southern | Alexandria, Va. |
| 1891 | Thomas, H. T | Det. & Mackinac | East Tawas, Mich. |
| 1892 | Thomas, J. J., Jr | Mobile & Ohio | Tuscaloosa, Ala. |
| 1883 | Thomas, W. H. | Southern | Washington, D. C. |
| 1890 | Thompson, C. A | Central of New Jersey | Jersey City, N. J. |
| 1896 | Thompson, Geo | Beech Creek | Jersey Shore, Pa. |
| 1895 | Thompson, W. F. | Kings Co. Elev. | Brooklyn, N. Y. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1883 | Thow, Wm | Government | Sydney, N. S. W. |
| 1892 | Todd, Louis C | Boston & Maine | Lyndonville, Vt. |
| 1898 | Tollerton, W. J | Oregon Short Line | Salt Lake City, Utah. |
| 1892 | Tomlinson, Jas. G | N. O. & N.-E | Meridian, Miss. |
| 1897 | Tomlinson, J. J | Mex. Northern | Escalon, Chihuahua, Mex. |
| 1893 | Tonge, John | Minn. & St. Louis | Minneapolis, Minn. |
| 1885 | Torrance, John | E. & T. H | Evansville, Ind. |
| 1896 | Tower, G. M | Fitchburg | Fitchburg, Mass. |
| 1892 | Townsend, Jos | Chic. & Alton | Bloomington, Ill. |
| 1896 | Tracy, W. L | Southern | Atlanta, Ga. |
| 1892 | Traver, W. H | Rand Drill Co., Monadnock Block, Chicago, Ill. | |
| 1883 | Tregelles, Henry | Care Norton, Megaw & Co., Rio de Janeiro, Brazil. | |
| 1892 | Tremp, A. E | C. C. C. & St. L | Indianapolis, Ind. |
| 1892 | Tresize, Thos | 1523 West Lanvale st., Baltimore, Md. | |
| 1896 | Tubbs, F. E | Jcknvlle., Tam. & K. W. | Palatka, Fla. |
| 1890 | Tuggle, S. R | Houston & Tex. Cent. | Houston, Tex. |
| 1890 | Turner, Calvin G | Phil. Wil. & Balto | Wilmington, Del. |
| 1889 | Turner, Chas. E | B. R. & P | Rochester, N. Y. |
| 1886 | Turner, J. S | W. Va. Cent. & Pitts | Elkins, W. Va. |
| 1890 | Turner, L. H | Pitts. & L. Erie | McKees Rocks, Pa. |
| 1886 | Twombly, A. W | Old Colony | Taunton, Mass. |
| 1883 | Twombly, Fred M | N. Y. N. H. & H | Boston, Mass. |
| 1890 | Tyrrell, Thos. H | Staten I. Rap. Transit | Whitehall st., N. Y. City. |
| | | | |
| 1889 | Vail, A | Western N. Y. & Pa | Buffalo, N. Y. |
| 1898 | Van Alstine, D | Louis. Hen. & St. Louis. | Cloverport, Ky. |
| 1890 | Van Brunt, G. E | Penna. & N.-Western | Bellwood, Pa. |
| 1896 | Van Cleve, J. R | Great Northern | Kalispell, Mont. |
| 1891 | Vauclain, Sam'l M | Baldwin Loco. Works, Philadelphia, Pa. | |
| 1898 | Vaughan, H. H | Phila. & Reading | Reading, Pa. |
| 1896 | Villasenor, Alberto | Ferro Carrel Central del Salvador, | La Union, Salvador, C. A. |
| 1892 | Vogt, A. S | Pennsylvania | Altoona, Pa. |
| | | | |
| 1892 | Wade, R. D | Baldwin Loco. Wks | Washington, D. C. |
| 1896 | Wagner, Jno. R | Del. Susq. & Schuyl. | Drifton, Pa. |
| 1892 | Waitt, A. M | L. S. & M. S | Cleveland, Ohio. |
| 1896 | Walker, C. E | B. & O. S.-W | Washington, Ind. |
| 1893 | Walker, Henry E | Mexican Southern | Pueblo, Mex. |
| 1891 | Wallis, J. M | Pennsylvania | Williamsport, Pa. |
| 1888 | Wallis, Philip | Lehigh Valley | Easton, Pa. |
| 1874 | Walsh, Thos | Louisville & Nashville | Howell, Ind. |
| 1896 | Walters, J. H | Louisville & Nashville | Anniston, Ala. |
| 1896 | Walton, E. A | Fitchburg | Boston, Mass. |
| 1896 | Ward, C. A | Bangor & Portland | Bangor, Pa. |
| 1887 | Ward, C. F | Duluth, Superior & West. | Cloquet, Minn. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1883 | Warren, Beriah | T. P. & W. | Peoria, Ill. |
| 1882 | Warren, W. B. | T. P. & W. | Peoria, Ill. |
| 1883 | Watts, Amos H. | Cincinnati Northern | Van Wert, Ohio. |
| 1896 | Waugh, L. H. | G. C. & S. F. | Cleburne, Tex. |
| 1894 | Weaver, Jas. N. | | Sayre, Pa. |
| 1887 | Webb, F. W. | London & North West | Crewe, England. |
| 1892 | Weiss, C. P. | Erie | Hornellsville, N. Y. |
| 1886 | Weisgerber, E. L. | Balto. & Ohio | Mt. Clare Shops, Baltimore, Md. |
| 1868 | Wells, Reuben | | Rogers Loco. Works, Paterson, N. J. |
| 1896 | West, A. J. | Tabor & Northern | Tabor, Iowa. |
| 1880 | West, G. W. | N. Y. O. & W. | Middletown, N. Y. |
| 1885 | White, A. M. | | Schenectady Loco. Works, Schenectady, N. Y. |
| 1894 | White, E. T. | Balto. & Ohio | Riverside, Baltimore, Md. |
| 1898 | Whyte, F. M. | Chi. & North-Western. | Chicago, Ill. |
| 1894 | Wiggin, Chas. H. | Boston & Maine | Concord, N. H. |
| 1884 | Wightman, D. A. | | Pitts. Loco. Works, Allegheny, Pa. |
| 1891 | Wilcox, W. J. | O. R. & S. C. | Blacksburg, S. C. |
| 1896 | Williams, Alfred | Paulista | Paulista, Brazil, S. A. |
| 1891 | Williams, E. A. | M. St. P. & S. S. M. | Minneapolis, Minn. |
| 1887 | Wilson, G. F. | C. R. I. & P. | Chicago, Ill. |
| 1898 | Witmer, J. W. | Detroit, Toledo & Milwaukee, | Marshall, Mich. |
| 1896 | Woodhouse, T. D. | Kan. City, Pitts. & Gulf. | Pittsburg, Kan. |
| 1896 | Worswick, J. E. | Ga. & Ala. | Americus, Ga. |
| | | | |
| 1896 | Yohn, C. R. | H. & B. T. Mtn. | Saxton, Pa. |
| 1895 | Young, W. H. | Florida So. | Sanford, Fla. |
| 1893 | Young, O. de | G. H. & S. A. | El Paso, Tex. |
| | | | |
| 1898 | Zerbee, F. J. | C. C. C. & St. L. | Wabash, Ind. |

## ASSOCIATE MEMBERS.

| JOINED. | NAME. | ADDRESS. |
|---|---|---|
| 1893 | Baker, Geo. H | Metropolitan Bldg, New York City. |
| 1898 | Basford, G. M | Morse Bldg., New York City. |
| 1898 | Bates, E. C | Crosby Steam Gauge & Valve Co., Boston, Mass. |
| 1898 | Crossman, W. D | Rookery Bldg., Chicago, Ill. |
| 1883 | Dean, F. W | 55 State street, Boston, Mass. |
| 1896 | Fowler, Geo. L | 53 Broadway, New York City. |
| 1880 | Gordon, Alex | Niles Tool Works, Hamilton, Ohio. |
| 1895 | Goss, W. F. M | Purdue University, Lafayette, Ind. |
| 1889 | Hill, John A | 256 Broadway, New York City. |
| 1893 | Leeds, Hon. John H | 318 Howard avenue, New Haven, Conn. |
| 1871 | Miles, F. B | Bement & Miles, Philadelphia, Pa. |
| 1897 | Moore, E. F | Railroad Commission, Lansing, Mich. |
| 1889 | Pomeroy, L. R | 33 Wall street, New York City. |
| 1893 | Robinson, Harry P | Monadnock Bldg., Chicago, Ill. |
| 1886 | Shaw, Thos | 915 Ridge street, Philadelphia, Pa. |
| 1889 | Smith, John Y | Doylestown, Pa. |
| 1882 | Smith, W. A | Old Colony Bldg., Chicago, Ill. |
| 1871 | Wheelock, Jerome | 98 Eastern ave., Worcester, Mass. |

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## HONORARY MEMBERS.

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1869 | Coolidge, G. A | | Charlestown, Mass. |
| 1870 | Cooper, H. L | | 4644 State street, Chicago, Ill. |
| 1895 | Coster, E. L | Assistant in Mechanical Engineering, Columbia University, Residence, Irvington. | 27 William st., New York City. |
| 1870 | Divine, J. F | W. & Weldon | Wilmington, N. C. |
| 1881 | Eastman, A. G | | Sutton, Que. |
| 1868 | Eddy, Wilson | | Springfield, Mass. |
| 1871 | Forney, M. N | | 501 Fifth avenue, New York City. |
| 1872 | Foss, J. M | Cent. Vermont | St. Albans, Vt. |
| 1885 | Galloway, A | C. H. & I | Indianapolis, Ind. |
| 1869 | Graham, Chas | | 401 Madison avenue, Scranton, Pa. |
| 1870 | Hodgman, S. A | | Lobdell Car Wheel Works, Wilmington, Del. |

| JOINED. | NAME. | ROAD. | ADDRESS. |
|---|---|---|---|
| 1874 | Jeffery, E. T. | Denver & Rio Grande | Denver, Colo. |
| 1868 | Johann, Jacob | | 1003 South Seventh street, Springfield, Ill. |
| 1868 | Kinsey, J. I. | Lehigh Valley | Easton, Pa. |
| 1878 | Maglenn, Jas. | Seaboard Air Line | Raleigh, N. C. |
| 1871 | McCrum, J. S. | | Kansas City, Mo. |
| 1891 | McKenna, John | I. D. & S. W | Indianapolis, Ind. |
| 1872 | Philbric, J. W | | Waterville, Maine. |
| 1873 | Prescott, G. H | | Logansport, Ind. |
| 1869 | Richards, George | | 14 Auburn street, Roxbury, Mass. |
| 1870 | Robinson, W. A | | Hamilton, Ont. |
| 1869 | Sellers, Morris | | Western Union Bldg., Chicago, Ill. |
| 1888 | Sheppard, F. L. | Pennsylvania | Altoona, Pa. |
| 1872 | Stearns, W. H | | Springfield, Mass. |
| 1883 | Sullivan, A. W. | Ill. Cent. | Chicago, Ill. |
| 1869 | Thompson, John | | 137 Webster street, East Boston, Mass. |
| 1870 | Towne, H. A. | | 236 First avenue, Minneapolis, Minn. |
| 1869 | White, J. L. | | Danville, Ill. |
| 1870 | Williams, E. H | | Baldwin Loco. Works, Philadelphia, Pa. |

# PROCEEDINGS.

The Thirty-first Annual Convention of the American Railway Master Mechanics' Association was called to order by President Leeds at 9:10 A.M. on Monday, June 20, 1898, at the Theater Saratoga, Saratoga, New York.

Prayer was offered by Bishop Newman.

PRESIDENT LEEDS then read the following address:

GENTLEMEN OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION:

In greeting and welcoming yourselves, your ladies and friends, it perhaps will not be considered out of place to touch lightly upon the reasons why this, the thirty-first convention, should have been called to meet for the fourth time at this place, especially as the action of your executive officers has, upon former occasions, been criticised, as apparently ignoring the expressed wish of the majority.

First, I am of the opinion that while we have been most courteously and heartily welcomed at all points where it has been my good fortune to meet with you, still, I cannot but feel that at no place have we met with a more cordial and whole-souled reception than at Saratoga, not by a select few, but apparently by the village at large. Then it must be borne in mind that the committee consists of representatives of two Associations, and the wishes of both memberships had to be consulted. Suffice it to say that the expressed wishes of all were given full consideration, and after due deliberation it was decided that while some other localities were very attractive, and would add a great deal of novelty to needed rest and recreation, at the same time there was none of them which combined as great a degree of comfort with the other essentials for the transaction of the business of as large conventions as ours. We hope such arrangements have been made, and will be carried out, as will induce our lady friends to say, "I am glad I came," for in my opinion one of the most glorious things (if not the greatest) this Association can pride itself upon, is the fact that with an attendance of considerably over a thousand, their surroundings are such that the ladies of our families take as great an interest in our conventions as the members themselves, and meet with past friends, and make new ones, with a cordiality that is admirable. In fact I know of no place where as sincere friendships are formed on as short an acquaintance, unless it be on shipboard, with the advantage decidedly in our favor, inasmuch as there is nothing promiscuous in our assemblage. While I appreciate the fact that this Association has great cause for congratulation as regards the good that has been accomplished in the past, and there has been a great deal added within the last year, still, to enumerate the advantages gained would be a reiteration of an oft-told and well known tale, and on the prin-

ciple that the outcome of posterity is of more importance to us than the history of ancestry, we will only touch upon the past, or even the present, in so far as it has a bearing upon the future.

I regret to say that the scholarships of the Association have not been as much sought after as in my opinion they should be. In fact, I cannot comprehend the lack of interest displayed. I sincerely hope it is not because our members are disposed to say they will not bring their sons up to follow in their footsteps. To any such I would put the query, In what walk of life is there as true independence as a first-class machinist enjoys? For quite a period I have been an employer. During that time there has never been a day that there have not been applications for positions on file in my office from competent men for every vacancy of any description, but during that whole time I have never known an occasion when we were not glad to obtain a first-class machinist. Even allowing that the young man should not follow the trade for a permanent means of livelihood or advancement, still, is it not well to furnish him with such an acquirement? And while I would not in any way disparage what, in my opinion, is a fact, that any young man who has the natural ability can without such a course master all the *essentials* of a technical education to fit him for the proper design of machinery, while the executive ability necessary to properly fill a leading position is inherent and cannot be acquired, still, in my opinion, the best method to obtain both a technical and a practical knowledge of our business is through a well-equipped technical school, followed by a proper apprenticeship under efficient supervision. In this connection it is my opinion that of two boys equally equipped with natural ability in all respects, except that one has had a regular and systematic training in a school and the other has not, the one with his mind in proper condition for receiving instructions from the start will make the greatest progress, and his apprenticeship should not of necessity be of as long duration as the other. Do not misunderstand me as saying that this applies to all graduates of technical schools, but if they have the ability a technical education is, in my opinion, a decided advantage.

My predecessor congratulated us that there had been a recognition of the fact that there was no sharp dividing line between theory and practice; and that each — the (so-called) practical men and the theoretical men — had learned to respect each other. This distinction of practical and theoretical men has always been beyond my comprehension. What constitutes either? Does the simple manipulation of tools constitute the practical man? And even in that does he not either form new theories or put in practice those of others that have preceded him? Does the fact that he did not learn them from books and under the direction of a professor change the fact that his lessons and deductions are based on the theories of others who have gone before him, leaving the results as an object lesson for him to profit by? Otherwise, why should he serve an apprenticeship? The theorist of the present day is an unknown quantity in actual service. The student is called upon to practically demonstrate his theory, and the only difference is in the method of research. Education in either line does not always imply valuable knowledge, nor can such knowledge be obtained so well in any other way as by experience and observation in the great laboratory of everyday practice. It may be said that there is a great deal taught in the schools that is superfluous. To this I cannot agree. Perhaps it is not fully essential that a railroad master mechanic should know how to properly lay out

the tooth of a gear wheel, still I do not think many of you will claim that this knowledge would work any harm. I repeat that it is a matter of sincere regret to me that only one scholarship has been awarded during the present year, and that not to a son of an employe, but to an employe himself.

Our committees will bring in very full reports upon matters of interest and importance in the economical operation of our department, and I would most earnestly urge a full discussion and consideration of all the points presented. Our most important work must of necessity be through committees, and the result of such work becomes a text for all. In fact, our work should add to the science of the care and operation of motive power and equipment, and to become such science it must be the exact truth.

In order to avoid reiteration and an unnecessary consumption of your time, the statement of the condition of our Association will be left entirely in the hands of the Secretary, who will embody it in his report.

The matter assigned to your Executive Committee, together with a special committee, of endeavoring to arrange the time of meeting of the two Associations so that members of both could attend without too much loss of time, could not be handled in strict accordance with instructions, inasmuch as the president of our sister Association did not consider the method proposed the proper manner to bring this matter before that body, and refused to convene the Executive Committee for conference; at the same time the officials assumed the responsibility of changing the dates of convening so as to shorten the time as much as possible. The consideration of this matter has firmly established in my mind the opinion that if there ever existed a need for two Associations, that necessity has passed. The members of either being eligible for membership in the other, and their duties of research and advancement being not only identical but to a very great extent carried on by members of both Associations, the two Associations should be consolidated for the mutual advantage of not only the members but of the railroads. Of the members of this Association who do not appear in the M. C. B. membership, a very large majority are Master Mechanics who have an interest in, and control, car departments, as well as motive power; yet they are represented by one member for the whole railroad system by which they are employed. For instance, I represent our road, yet most assuredly the ten Master Mechanics employed by us are just as much interested in the maintenance of our equipment as though they bore the title of Master Car Builder. If the two Associations were combined the work could be done with much less loss of time. For instance, two days are given to the opening, the election of officers and other incidental work consumes about all of two days. All this could and would be condensed into one day for each, and thus save two days; and if our work was largely done by committees, as in my opinion it should be, one week would suffice for the actual attendance. Besides this, in my opinion, a great deal better results could be obtained by one organization as strong as this would be than can possibly be by the two.

It has for many years been my idea that all equipment that is interchanged should be considered as common equipment of the country, and be as uniform in construction as the standards of any one road. This can only be achieved by the recognition of a common bureau or head, on the same principle that the head of a department decides the standards for a system. It is scarcely probable that all designs originate with that one head, but far more probable that it is the result

of suggestions of many; so, in case a committee was appointed by the organization, they would receive suggestions from all, and nearly everyone would have good reasons to advance for his manner of construction, and if this committee had one or two experts employed to analyze all such ideas as were presented, and to investigate reports of facts gathered from observation, they should be better enabled to recommend a standard for all classes of interchange than a committee who undertake such investigation in addition to their other manifold duties, and (may I whisper it?) further hampered by the idea that theirs are the only methods worthy of adoption. Another thing, this Association should be the fountain to furnish information as to what type and size of motive power is best suited to certain service under special or varied conditions. This, in my opinion, can best be obtained by comparative tests, under close observation of the work performed by the various types in actual service by unprejudiced parties, and I know of no method by which this could be as well accomplished as by the appointment of a committee who, by their mechanical skill and practical knowledge of all the requirements, were capable of judging of the merits of such matter when presented, and empowering them to employ such experts as necessary to collect data and outline suggestions of what should be adopted as standard for all interchange equipment, and to make such practical comparative tests of power as directed, making a summarized report to them.

I wish to thank the gentlemen who have addressed us, and the officials and members of committees of the Association, who have rendered valuable assistance in the business of the last year, and I ask your hearty co-operation in making this a profitable as well as a pleasant meeting. And now, hoping that this will be the only infliction imposed upon either members or friends, I will close, with especial thanks to all for having borne it so patiently.

The following members were present:

Aiken, C. L.
Aldcorn, T.
Allen, G. S.
Arp, W. C.
Atkinson, R.
Bartlett, H.
Barhydt, J. A.
Basford, G. M.
Bean, John.
Beltz, A. J.
Blackall, R. C.
Blackwell, C.
Bradeen, J. O.
Bradley, W. F.
Branch, G. E.
Brangs, P. H.
Briggs, R. H.
Bronner, E. D.
Brooke, G. D.
Brown, D.
Brown, W. A.
Browne, T. R.
Bryan, H. S.
Bushnell, R. W.
Campbell, J. D.
Carson, M. T.
Chase, F. A.
Clarke, I. W.
Clifford, J. G.
Cloud, J. W.
Cole, F. J.
Conolly, J. J.
Cooke, Allen.
Cooper, C. J.
Cory, C. H.
Crossman, W. D.
Cullen, James.
Cushing, G. W.
Davis, E. E.
Delaney, C. A.
Delaney, H.
Dolan, S. M.
Dunn, J. F.
Ennis, W. C.
Forney, M. N.
Forsyth, William.
Foster, W. A.
Foulk, John.
Fowler, G. L.
Fuller, C. E.
Gaines, F. F.
Garstang, William.
Gentry, T. W.
Glass, J. C.
Gordon, H. D.
Goss, W. F. M.
Graham, Jr., Charles.

Graham, J. A.
Groves, J. R.
Haskell, B.
Hatswell, T. J.
Hatswell, Jr., T. J.
Hawksworth, D.
Hayward, H. S.
Heers, L. B.
Henderson, G. R.
Hennessey, T. J.
Hibbard, H. Wade.
Hickey, John.
Horrigan, John.
Howard, C. H.
Humphrey, A. L.
Hyndman, F. T.
Johnson, R. H.
Joughins, G. R.
Kells, W.
Kenney, G. W.
Killen, W. E.
King, D. M.
Kistler, L.
Lawler, F. M.
Lawes, T. A.
Leeds, J. H.
Leeds, P.
Lloyd, T. S.
Lyon, Tracy.
Mackenzie, J.
Mackinnon, G. S.
Manchester, A. E.
Marden, J. W.
Marshall, E. S.
Marshall, W. H.
McConnell, J. H.
McIntosh, William.
Medway, J.
Mellin, C. J.
Miller, G. W.
Miller, E. A.
Miller, R.
Minshull, P. H.
Minto, H. M.
Mitchell, A. E.
Monkhouse, H.
Montgomery, W.
Moore, E. F.
Morris, W. S.
Neubert, G. T.
Neuffer, J. G.
Newell, T. W.
Nuttall, W. H.
O'Herin, W.
Peck, P. H.
Pflager, H. M.
Pomeroy, L. R.
Reid, M. M.
Rettew, C. E.
Richards, G. F.
Rickert, M.
Riley, G. N.
Robinson, F.
Robinson, H. P.
Robinson, J. T.
Rumney, T.
Sague, J. E.
Schaefer, H.
Schlacks, H.
Setchel, J. H.
Sinclair, A.
Small, H. J.
Smith, J. Y.
Smith, W. T.
Stewart, O.
Soule, R. H.
Tandy, H.
Taylor, John.
Thomas, W. H.
Thompson, George.
Tonge, John.
Tower, G. M.
Traver, W. H.
Turner, C. G.
Turner, C. E.
Turner, J. S.
Turner, L. H.
Tyrrell, T. H.
Vaughan, H. H.
Van Alstine, D.
Wagner, J. R.
Waitt, A. M.
Warren, W. B.
Watts, A. H.
Weaver, J. N.
Weiss, C. P.
West, G. W.
White, A. M.
Whyte, F. M.
Wightman, D. A.
Witmer, J. W.

THE PRESIDENT: I wish to say that we were disappointed somewhat in regard to an address to the Association which we had expected. While our committee will undoubtedly return a vote of thanks to Bishop Newman for his kindness in coming before us and opening this convention with prayer, I would respectfully ask the convention to indorse my thanks to Bishop Newman by a rising vote.

The audience rose in compliance with the President's suggestion.

THE PRESIDENT: It is our custom to take a recess at this stage of the proceedings for about five minutes to allow those not attending the convention as members, to retire.

[A recess of five minutes was then taken.]

THE PRESIDENT: Gentlemen will come to order.

MR. MACKENZIE: I may be a little bit out of order, but perhaps you will appreciate my point before I get through. I have listened with a good deal of interest to the President's address. Heretofore it has been the custom of the Presidents of the Association to suggest many subjects for the consideration of the members, and there has been no attention paid to them. Now, I suggest that a committee be appointed to take up the various recommendations of the President as stated in his address, which committee shall report to this convention as to suitable subcommittees to be appointed to carry out the suggestions of the President. (Seconded.)

THE PRESIDENT: Gentlemen, while I have not said anything but what I meant and believe should be done, I would suggest that this action would more properly come under the head of new business, and that we should proceed in our regular order of business unless some reason appears why that committee should be appointed at once, and as I do not think we will consolidate today, I would ask Mr. Mackenzie to withhold his motion until the order of new business is reached. Will that be satisfactory?

MR. MACKENZIE: With the consent of the seconder I will certainly do so, with the understanding that the President shall appoint that committee.

THE PRESIDENT: No; I do not think that it would be either justice to the Association or exactly in good taste for the President or the Association to appoint a committee to act on suggestions he has made himself. I shall request and most earnestly urge upon the convention to appoint that committee, and in the meantime to be thinking up some good old heads to be put on that committee, like Mackenzie. (Applause.)

MR. SETCHEL: Mr. President, it seems to me it is perfectly in order to refer the President's message to a committee. I do not think there is any doubt about that at all.

THE PRESIDENT: I have no objection to the reference, but it will be my ruling that it should come under the order of new business. The next order of business is the reading of the minutes of the last convention. As those minutes have all been printed, unless some objection is raised or some error has been discovered, they will stand as printed. We will listen to the report of the Secretary.

Secretary Cloud read his annual report as follows:

SECRETARY'S REPORT.

At the date of the last convention the membership of the Association was as follows:

| | |
|---|---|
| Active members | 577 |
| Honorary members | 25 |
| Associate members | 17 |
| Total | 619 |

Since that date seven active and three honorary members have died, six active members have resigned and two active members have been elected honorary members. During this time thirty-six new active members have been added to the rolls, and one new associate member elected, so that the membership at the present time is as follows:

| | |
|---|---|
| Active members | 599 |
| Honorary members | 25 |
| Associate members | 18 |
| Total | 642 |

The members who have died during the year, as far as the records of the Secretary show, are as follows:

J. T. Bryant, A. A. Daniels, F. J. Ferry, J. M. Hurst, D. G. Mott, P. H. Schreiber, J. P. Seward, William Lannan, T. Mulligan and B. R. Harding.

The cash collected by the Secretary since the last report and up to June 7, 1898, the date of the closing of the books preparatory to this report, is as follows:

| | |
|---|---|
| To dues collected from members | $2,780.00 |
| " Sale of Proceedings, Subscriptions to Printing Fund | 846.24 |
| " " " " Miscellaneous | 107.55 |
| " Exchange | .78 |
| " Interest on Bank Balances | .71 |
| Total receipts | $3,735.28 |

The disbursements by the Secretary during the same time have been as follows:

| | |
|---|---|
| By Paid Expressage | $ 4.95 |
| " " Exchange | 17.75 |
| " " Stamps and Stamped Envelopes | 208.64 |
| " " Office Stationery and Supplies | 18.73 |
| " " Telegrams | 3.81 |
| " " Expenses at Convention of 1897 | 60.59 |
| " " Printing | 1,313.23 |
| " " Electros, Zinc Cuts, etc | 83.86 |
| " " Salary | 1,200.00 |
| " " R. W. Ryan, Reporting Convention, 1897 | 193.00 |
| " " Tracings, Blue Prints, etc | 36.00 |
| " " Expenses of Committees | 39.60 |
| " " Balance remitted to Treasurer June 7, 1898 | 555.12 |
| Total disbursements | $3,735.28 |

It will be seen that there are no funds belonging to the Association now in the hands of the Secretary. There are no unpaid bills against the Association, nor any outstanding accounts unpaid.

The arrears of unpaid dues amount to $775, a statement of which is hereto attached, for the information and inspection of members.

A detailed statement of the dues collected during the year is also attached as a part of this report.

Of the four scholarships of the Association at the Stevens Institute of Technology three are taken, two of which will be vacant in two more years and one in three years. One is now vacant. Several members have been furnished with the necessary information for their sons to compete at the June examinations for entrance next fall to the Institute under this scholarship.

Respectfully submitted,

JNO. W. CLOUD,
*Secretary.*

DETAILED STATEMENT OF DUES COLLECTED FROM MEMBERS.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1897. | | | | | | *Brought forward...* | $160.00 |
| June | 2 | H. D. Page ....... $ | 5.00 | June | 18 | I. W. Clarke. .... | 5.00 |
| " | 2 | R. Allin .......... | 5.00 | " | 18 | F. C. Cleaver...... | 5.00 |
| " | 2 | W. L. Tracy ...... | 5.00 | " | 18 | C. J. Clifford ...... | 5.00 |
| " | 2 | F. Stamelin ....... | 10.00 | " | 18 | J. Cockfield ....... | 5.00 |
| " | 2 | G. E. Van Brunt... | 10.00 | " | 18 | G. W. Cushing .... | 5.00 |
| " | 18 | C. L. Aiken....... | 10.00 | " | 18 | W. C. Dallas ...... | 5.00 |
| " | 18 | G. S. Allen ....... | 5.00 | " | 18 | H. Delaney ....... | 5.00 |
| " | 18 | W. C. Arp ... .... | 5.00 | " | 18 | M. J. Drury....... | 5.00 |
| " | 18 | W. L. Austin...... | 5.00 | " | 18 | W. C. Ennis..... . | 10.00 |
| " | 18 | R. Atkinson ....... | 5.00 | " | 18 | P. P. Foller....... | 5.00 |
| " | 18 | J. E. Battye....... | 5.00 | " | 18 | W. A. Foster...... | 5.00 |
| " | 18 | John Bean ........ | 5.00 | " | 18 | C. E. Fuller....... | 5.00 |
| " | 18 | John Bisset........ | 5.00 | " | 18 | R. M. Galbraith. .. | 5.00 |
| " | 18 | R. C. Blackall ..... | 5.00 | " | 18 | A. Gardner........ | 5.00 |
| " | 18 | J. M. Boon........ | 5.00 | " | 18 | W. Garstang ...... | 5.00 |
| " | 18 | I. Bond........... | 5.00 | " | 18 | T. W. Gentry ..... | 5.00 |
| " | 18 | A. A. Bradeen..... | 5.00 | " | 18 | A. W. Gibbs ...... | 10.00 |
| " | 18 | J. O. Bradeen...... | 5.00 | " | 18 | W. F. M. Goss .... | 5.00 |
| " | 18 | G. E. Branch...... | 5.00 | " | 18 | J. A. Graham...... | 5.00 |
| " | 18 | P. H. Brangs...... | 5.00 | " | 18 | A. W. Greenwood.. | 5.00 |
| " | 18 | R. H. Briggs ...... | 5.00 | " | 18 | J. C. Haggett...... | 10.00 |
| " | 18 | D. Brown......... | 5.00 | " | 18 | J. A. Hanglin ..... | 5.00 |
| " | 18 | W. A. Brown...... | 5.00 | " | 18 | B. Haskell ........ | 5.00 |
| " | 18 | T. R. Browne ..... | 5.00 | " | 18 | T. J. Hatswell..... | 5.00 |
| " | 18 | J. T. Bryant ....... | 5.00 | " | 18 | L. B. Heers ... ... | 5.00 |
| " | 18 | G. W. Butcher..... | 5.00 | " | 18 | G. R. Henderson... | 5.00 |
| " | 18 | W. L. Boyle ...... | 15.00 | " | 18 | T. S. Inge......... | 5.00 |
| | | *Carried forward...* | $160.00 | | | *Carried forward...* | $310.00 |

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|---|---|---|---|
| | | *Brought forward...* | $310.00 |
| June | 18 | William Jennings... | 5.00 |
| " | 18 | J. A. Keegan...... | 5.00 |
| " | 18 | J. E. Keegan...... | 5.00 |
| " | 18 | W. Kells......... | 5.00 |
| " | 18 | G. W. Kenney..... | 5.00 |
| " | 18 | W. E. Killen...... | 10.00 |
| " | 18 | L. Kistler......... | 5.00 |
| " | 18 | F. G. Lauer....... | 5.00 |
| " | 18 | F. M. Lawler...... | 5.00 |
| " | 18 | A. L. Leach....... | 5.00 |
| " | 18 | C. W. Lee........ | 5.00 |
| " | 18 | P. Leeds.......... | 5.00 |
| " | 18 | J. H. Leeds....... | 5.00 |
| " | 18 | W. H. Lewis...... | 5.00 |
| " | 18 | T. S. Lloyd....... | 5.00 |
| " | 18 | P. Maher......... | 5.00 |
| " | 18 | E. P. Mallison..... | 5.00 |
| " | 18 | J. H. Manning..... | 5.00 |
| " | 18 | E. S. Marshall..... | 5.00 |
| " | 18 | J. H. McConnell... | 5.00 |
| " | 18 | A. McDuff........ | 5.00 |
| " | 18 | W. McIntosh...... | 5.00 |
| " | 18 | J. McNaughton.... | 5.00 |
| " | 18 | J. Medway........ | 5.00 |
| " | 18 | G. W. Miller...... | 5.00 |
| " | 18 | P. H. Minshull.... | 5.00 |
| " | 18 | J. H. Moore....... | 5.00 |
| " | 18 | E. F. Moore....... | 5.00 |
| " | 18 | J. G. Neuffer...... | 5.00 |
| " | 18 | L. C. Noble....... | 5.00 |
| " | 18 | W. H. Nuttall..... | 5.00 |
| " | 18 | J. O'Brien......... | 5.00 |
| " | 18 | W. O'Herin....... | 5.00 |
| " | 18 | H. Osborne........ | 5.00 |
| " | 18 | W. H. Owens...... | 5.00 |
| " | 18 | C. H. Quereau.... | 5.00 |
| " | 18 | C. E. Rettew...... | 5.00 |
| " | 18 | O. H. Reynolds.... | 5.00 |
| " | 18 | M. Rickert........ | 5.00 |
| " | 18 | J. W. Roberts...... | 5.00 |
| " | 18 | C. B. Royal....... | 5.00 |
| " | 18 | J. J. Ryan........ | 5.00 |
| " | 18 | J. E. Sague........ | 5.00 |
| " | 18 | E. I. Sandt........ | 5.00 |
| | | *Carried forward...* | $535.00 |

| | | | |
|---|---|---|---|
| | | *Brought forward...* | $535.00 |
| June | 18 | D. O. Shaver...... | 5.00 |
| " | 18 | A. Sinclair........ | 5.00 |
| " | 18 | F. C. Smith....... | 5 00 |
| " | 18 | W. Smith......... | 5.00 |
| " | 18 | R. H. Soule....... | 5.00 |
| " | 18 | H. N. Sprague..... | 5.00 |
| " | 18 | S. A. Steele....... | 10.00 |
| " | 18 | O. Stewart........ | 5.00 |
| " | 18 | S. E. Stout........ | 5.00 |
| " | 18 | R. D. Sutherland... | 5.00 |
| " | 18 | W. Swanston...... | 5.00 |
| " | 18 | H. Tandy......... | 5.00 |
| " | 18 | C. M. Taylor...... | 5.00 |
| " | 18 | J. Taylor.......... | 5.00 |
| " | 18 | H. T. Thomas..... | 5.00 |
| " | 18 | W. H. Thomas.... | 5.00 |
| " | 18 | George Thompson.. | 5.00 |
| " | 18 | W. F. Thompson... | 5.00 |
| " | 18 | L. C. Todd........ | 10.00 |
| " | 18 | G. M. Tower...... | 5.00 |
| " | 18 | W. H. Traver..... | 5.00 |
| " | 18 | S. R. Tuggle...... | 5.00 |
| " | 18 | J. S. Turner....... | 5.00 |
| " | 18 | S. M. Vauclain.... | 5.00 |
| " | 18 | A. M. Waitt....... | 5.00 |
| " | 18 | P. Wallis......... | 5.00 |
| " | 18 | B. Warren......... | 5.00 |
| " | 18 | W. B. Warren..... | 5.00 |
| " | 18 | R. Wells.......... | 5.00 |
| " | 18 | A. T. West........ | 5.00 |
| " | 18 | G. W. West....... | 5.00 |
| " | 18 | A. M. White...... | 5.00 |
| " | 18 | C. A. Delany...... | 5.00 |
| " | 18 | F. J. Pease....... | 5.00 |
| " | 18 | H. T. Payton...... | 5.00 |
| " | 18 | J. Glaser.......... | 5.00 |
| " | 18 | T. J. Hennessey.... | 5.00 |
| " | 18 | A. G. Elvin....... | 5.00 |
| " | 18 | G. W. Hepburn.... | 5.00 |
| " | 18 | C. K. Bowles...... | 5.00 |
| " | 18 | H. W. Hibbard.... | 5.00 |
| " | 18 | R. Hill........... | 5.00 |
| " | 18 | J. A. Hill......... | 5.00 |
| " | 18 | M. L. Hinman..... | 5.00 |
| | | *Carried forward...* | $765.00 |

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|---|---|---|---|
| | | *Brought forward...* | $765.00 |
| June | 18 | W. L. Holman..... | 5.00 |
| " | 18 | E. E. Hudson...... | 5.00 |
| " | 18 | A. L. Humphrey... | 5.00 |
| " | 18 | F. T. Hyndman ... | 5.00 |
| " | 18 | Jacob Losey....... | 10.00 |
| " | 18 | George Gilmore.... | 10.00 |
| " | 18 | I. Conroe ......... | 5.00 |
| " | 18 | W. Greene ........ | 5.00 |
| " | 18 | T. D. Woodhouse.. | 5.00 |
| " | 18 | W. Hutchison ..... | 5.00 |
| " | 18 | O. de Young....... | 5.00 |
| " | 18 | T. Walsh ......... | 10.00 |
| " | 18 | G. H. Prescott..... | 5.00 |
| " | 28 | C. C. Leech....... | 5.00 |
| " | 29 | E. M. Herr........ | 5.00 |
| " | 29 | E. L. Coster....... | 5.00 |
| " | 30 | A. A. Daniels ..... | 5.00 |
| July | 1 | C. H. Barnes ...... | 5.00 |
| " | 1 | J. W. Cloud....... | 5.00 |
| " | 1 | G. W. Rhodes . ... | 5.00 |
| " | 1 | J. Foulk .......... | 5.00 |
| " | 1 | C. Hackney ....... | 5.00 |
| " | 1 | J. B. Barnes....... | 5.00 |
| " | 1 | H. Ryder ......... | 15.00 |
| " | 6 | C. H. Wiggin...... | 10.00 |
| " | 6 | M. J. Redding..... | 5.00 |
| " | 6 | F. A. Given....... | 10.00 |
| " | 6 | W. J. McLean..... | 5.00 |
| " | 6 | J. C. Shields....... | 5.00 |
| " | 6 | A. Mitchell........ | 5.00 |
| " | 6 | E. T. Sumner...... | 10.00 |
| " | 6 | L. B. Paxson ...... | 5.00 |
| " | 6 | J. Cullinan ........ | 5.00 |
| " | 6 | P. H. Murphy ..... | 5.00 |
| " | 6 | J. L. Brown....... | 5.00 |
| " | 6 | S. T. Balkam...... | 5.00 |
| " | 6 | T. A. Fraser....... | 5.00 |
| " | 6 | W. E. Amann..... | 10.00 |
| " | 7 | A. Vail........... | 5.00 |
| " | 7 | G. B. Ross........ | 5.00 |
| " | 7 | H. J. Small........ | 5.00 |
| " | 7 | W. H. Taylor...... | 5.00 |
| " | 7 | R. Moran ......... | 5.00 |
| " | 7 | R. J. Gross........ | 5.00 |
| | | *Carried forward...* | $1,030.00 |

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|---|---|---|---|
| | | *Brought forward...* | $1,030.00 |
| July | 7 | F. J. Cole......... | 5.00 |
| " | 8 | P. H. Peck ....... | 5.00 |
| " | 8 | E. L. Weisgerber... | 5.00 |
| " | 8 | C. P. Weiss ....... | 5.00 |
| " | 8 | J. Wheelock....... | 5.00 |
| " | 8 | G. Donahue....... | 5.00 |
| " | 8 | V. B. Lang........ | 5.00 |
| " | 8 | F. Hufsmith....... | 5.00 |
| " | 8 | W. Fuller......... | 5.00 |
| " | 8 | A. E. Benson ...... | 5.00 |
| " | 9 | J. B. Johnson...... | 5.00 |
| " | 9 | C. M. Babcock .... | 5.00 |
| " | 9 | A. Pilsbury........ | 5.00 |
| " | 9 | J. Potton.......... | 5.00 |
| " | 10 | A. McCormick..... | 5.00 |
| " | 10 | A. G. Leonard..... | 5.00 |
| " | 10 | W. S. Morris ...... | 5.00 |
| " | 12 | W. S. Hancock.... | 5.00 |
| " | 12 | A. B. Johnson..... | 5.00 |
| " | 12 | F. Roth........... | 5.00 |
| " | 12 | W. H. V. Rosing .. | 5.00 |
| " | 12 | H. Elliott......... | 5.00 |
| " | 12 | R. Quayle......... | 5.00 |
| " | 12 | H. Bartlett ........ | 5.00 |
| " | 14 | J. G. Beaumont.... | 5.00 |
| " | 14 | J. D. Barnett ...... | 5.00 |
| " | 14 | J. R. Groves....... | 5.00 |
| " | 15 | J. W. Addis ....... | 5.00 |
| " | 15 | J. R. Van Cleve.... | 5.00 |
| " | 15 | H. S. Hayward .... | 5.00 |
| " | 15 | J. L. Driscoll...... | 5.00 |
| " | 15 | T. H. Tyrrell...... | 5.00 |
| " | 15 | C. E. Turner ...... | 5.00 |
| " | 15 | J. Cullen.......... | 5.00 |
| " | 15 | W. H. Lewis...... | 5.00 |
| " | 16 | H. M. Sehrt....... | 5.00 |
| " | 16 | J. Hinchey........ | 5.00 |
| " | 16 | A. J. Cromwell..... | 5.00 |
| " | 16 | J. Horrigan........ | 5.00 |
| " | 16 | F. D. Casanave .... | 5.00 |
| " | 16 | C. G. Turner ...... | 5.00 |
| " | 17 | W. E. Symons..... | 5.00 |
| " | 17 | F. Bruce.......... | 5.00 |
| " | 17 | F. J. Leigh........ | 5.00 |
| | | *Carried forward...* | $1,250.00 |

| | | | |
|---|---|---|---|
| | | *Brought forward...* | $1,250.00 |
| July | 19 | D. J. Justice....... | 5.00 |
| " | 19 | A. J. Pitkin........ | 5.00 |
| " | 19 | C. W. Rickard..... | 5.00 |
| " | 19 | F. W. Dean...... | 5.00 |
| " | 19 | R. C. Esson....... | 5.00 |
| " | 19 | T. Millen ......... | 5.00 |
| " | 19 | O. Antz........... | 5.00 |
| " | 19 | G. F. Wilson...... | 5.00 |
| " | 19 | H. M. Pflager ..... | 5.00 |
| " | 20 | C. H. Prescott..... | 5.00 |
| " | 21 | O. Clark.......... | 5.00 |
| " | 21 | J. Kirk ........... | 5.00 |
| " | 21 | E. E. Davis ....... | 5.00 |
| " | 21 | G. L. Dickson..... | 5.00 |
| " | 21 | C. J. McMasters.... | 5.00 |
| " | 21 | W. H. Brehm...... | 5.00 |
| " | 21 | C. J. Mellin....... | 5.00 |
| " | 21 | G. L. Potter....... | 5.00 |
| " | 21 | W. W. Atterbury... | 5.00 |
| " | 22 | J. S. Chambers..... | 5.00 |
| " | 22 | A. Gordon ........ | 5.00 |
| " | 22 | J. J. Conolly ...... | 5.00 |
| " | 23 | T. Shaw.......... | 5.00 |
| " | 23 | L. S. Randolph .... | 10.00 |
| " | 23 | G. Knapp......... | 5.00 |
| " | 23 | T. W. Place....... | 5.00 |
| " | 23 | J. L. Greatsinger... | 5.00 |
| " | 23 | H. S. Bryan....... | 5.00 |
| " | 24 | L. Greaven........ | 5.00 |
| " | 24 | W. O. Lucas ...... | 5.00 |
| " | 24 | N. W. Sample..... | 5.00 |
| " | 26 | J. M. Wallis....... | 5.00 |
| " | 26 | C. A. Thompson ... | 5.00 |
| " | 26 | T. Lyon .......... | 5.00 |
| " | 26 | W. L. Gilmore .... | 5.00 |
| " | 27 | G. James.. ....... | 5.00 |
| " | 27 | C. H. Doebler..... | 5.00 |
| " | 27 | A. Beckert ........ | 5.00 |
| " | 28 | John Ellis......... | 5.00 |
| " | 28 | J. J. Ellis ........ | 5.00 |
| Aug. | 5 | W. H. Young...... | 5.00 |
| " | 5 | H. Politt.......... | 5.00 |
| " | 5 | A. S. Grant........ | 5.00 |
| " | 5 | J. W. Hall........ | 5.00 |
| | | *Carried forward...* | $1,475.00 |

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|---|---|---|---|
| | | *Brought forward...* | $1,475.00 |
| Aug. | 5 | J. Hewitt ......... | 5.00 |
| " | 5 | C. H. Howard..... | 5.00 |
| " | 5 | M. D. Brown...... | 5.00 |
| " | 5 | J. R. Garrick...... | 5.00 |
| " | 6 | A. E. Mitchell..... | 5.00 |
| " | 6 | N. W. Norsworthy.. | 5.00 |
| " | 6 | W. Renshaw ...... | 5.00 |
| " | 7 | W. L. Hoffecker ... | 5.00 |
| " | 7 | R. E. French...... | 5.00 |
| " | 7 | A. Cooke ......... | 5.00 |
| " | 7 | J. Gill ............ | 5.00 |
| " | 7 | H. D. Gordon..... | 5.00 |
| " | 9 | J. J. Tomlinson .... | 5.00 |
| " | 10 | H. E. Walker...... | 5.00 |
| " | 11 | M. M. Reid ....... | 5.00 |
| " | 12 | E. Ryan .... ..... | 5.00 |
| " | 12 | D. Hawksworth.... | 5.00 |
| " | 12 | H. Schlacks....... | 5.00 |
| " | 16 | J. R. Wagner...... | 5.00 |
| " | 18 | J. W. Marden ..... | 5.00 |
| " | 19 | W. I. Cooke....... | 5.00 |
| " | 19 | W. Augustus ...... | 5.00 |
| " | 23 | E. A. Williams .... | 5.00 |
| " | 24 | J. Mackenzie ...... | 5.00 |
| " | 26 | A. Santer ......... | 5.00 |
| " | 26 | R. J. Callender .... | 5.00 |
| " | 30 | J. M. Keith ....... | 5.00 |
| " | 30 | D. D. Briggs ...... | 5.00 |
| Sept. | 2 | A. Villesenor ...... | 5.00 |
| " | 2 | J. F. Dunn........ | 5.00 |
| " | 2 | C. A. De Haven... | 5.00 |
| " | 2 | J. Torrance........ | 5.00 |
| " | 8 | A. M. Belcher..... | 5.00 |
| " | 8 | R. W. Bushnell.... | 5.00 |
| " | 8 | A. Fenwick....... | 5.00 |
| " | 9 | J. G. Tomlinson.... | 5.00 |
| " | 9 | W. H. Taft........ | 5.00 |
| " | 10 | A. L. Studer ...... | 5.00 |
| " | 13 | J. S. Cook ........ | 5.00 |
| " | 13 | W. Forsyth........ | 5.00 |
| " | 15 | G. A. Miller....... | 5.00 |
| " | 25 | F. W. Johnstone... | 5.00 |
| " | 27 | F. E. Tubbs....... | 10.00 |
| " | 27 | W. R. Deeble. .... | 10.00 |
| | | *Carried forward...* | $1,705.00 |

| | | |
|---|---|---|
| | *Brought forward*... | $1,705.00 |
| Sept. 27 | F. T. Rotheram.... | 5.00 |
| Oct. 2 | W. D. Holland.... | 5.00 |
| " 7 | A. Williams....... | 5.00 |
| " 11 | J. H. Buckalew.... | 5.00 |
| " 13 | F. J. Ferry........ | 5.00 |
| " 16 | W. Cross.......... | 5.00 |
| " 16 | M. J. Rogers...... | 5.00 |
| " 16 | H. M. C. Skinner.. | 5.00 |
| " 18 | W. J. Wilcox...... | 5.00 |
| " 20 | A. R. Barrow...... | 5.00 |
| " 25 | L. R. Pomeroy.... | 5.00 |
| " 25 | A. L. Beattie...... | 5.00 |
| " 29 | J. B. Michael...... | 5.00 |
| " 30 | G. W. Stevens..... | 5.00 |
| Nov. 8 | J. Collinson....... | 5.00 |
| " 8 | F. W. Webb....... | 5.00 |
| " 8 | L. M. Butler...... | 5.00 |
| " 12 | M. N. Forney..... | 5.00 |
| " 16 | T. J. Hatswell, Jr.. | 5.00 |
| " 16 | F. Mertsheimer.... | 5.00 |
| " 19 | C. H. Cory........ | 5.00 |
| " 24 | C. De Grass....... | 5.00 |
| " 29 | F. R. F. Brown.... | 5.00 |
| " 29 | S. K. Dickerson... | 5.00 |
| " 30 | E. C. Hiser....... | 10.00 |
| Dec. 6 | J. Macbeth........ | 5.00 |
| " 9 | A. Mitchell........ | 5.00 |
| " 14 | F. A. Chase....... | 5.00 |
| " 15 | J. Strode.......... | 5.00 |
| " 20 | F. W. Twombly... | 5.00 |
| " 20 | F. B. Griffith...... | 5.00 |
| " 28 | J. R. Spragge...... | 5.00 |
| " 29 | G. L. Fowler...... | 5.00 |
| " 29 | George Gregory.... | 5.00 |
| " 30 | J. Tonge.......... | 5.00 |
| " 30 | P. F. Lonergan.... | 5.00 |
| 1898 | | |
| Jan. 4 | S. P. Bush........ | 5.00 |
| " 4 | J. D. Campbell..... | 5.00 |
| " 8 | A. Gould......... | 5.00 |
| " 8 | J. L. Lawrence.... | 5.00 |
| " 11 | G. W. Buck....... | 5.00 |
| " 12 | J. Fitzmorris...... | 5.00 |
| " 12 | P. E. Garrison..... | 5.00 |
| | *Carried forward*... | $1,925.00 |

| | | |
|---|---|---|
| | *Brought forward*... | $1,925.00 |
| Jan. 12 | C. R. Yohn....... | 5.00 |
| " 12 | W. T. Reed....... | 10.00 |
| " 12 | G. S. MacKinnon.. | 5.00 |
| " 12 | W. J. Hemphill.... | 5.00 |
| " 13 | J. Hewitt......... | 5.00 |
| " 13 | T. E. Adams...... | 5.00 |
| " 13 | J. Hainen......... | 5.00 |
| " 14 | S. Higgins........ | 5.00 |
| " 17 | I. N. Kalbaugh.... | 5.00 |
| " 17 | H. Stillman....... | 10.00 |
| " 17 | T. W. Heintzelman. | 5.00 |
| " 17 | D. A. Wightman... | 5.00 |
| " 17 | J. H. Setchel...... | 5.00 |
| " 18 | C. E. Slayton...... | 5.00 |
| " 18 | J. M. Coale........ | 5.00 |
| " 19 | F. B. Smith........ | 5.00 |
| " 19 | T. Downing....... | 5.00 |
| " 21 | J. M. Davis....... | 5.00 |
| " 21 | J. W. Sanford...... | 5.00 |
| " 22 | P. C. Rusch....... | 5.00 |
| " 25 | T. McNabb....... | 5.00 |
| " 26 | J. N. Sanborn...... | 5.00 |
| " 26 | H. A. Childs...... | 5.00 |
| " 26 | C. Robkin......... | 5.00 |
| " 27 | J. I. Kinsey....... | 5.00 |
| " 27 | J. W. Hill........ | 5.00 |
| " 28 | A. E. Manchester.. | 5.00 |
| " 31 | George Gibbs...... | 5.00 |
| " 31 | W. P. Orland...... | 5.00 |
| Feb. 3 | W. A. Smith...... | 5.00 |
| " 3 | C. F. Lape........ | 5.00 |
| " 5 | E. A. Miller....... | 5.00 |
| " 7 | A. E. Tremp...... | 5.00 |
| " 7 | R. English........ | 5.00 |
| " 7 | A. S. Erskine...... | 5.00 |
| " 8 | T. A. Lawes...... | 5.00 |
| " 8 | B. F. Marshall..... | 5.00 |
| " 10 | T. A. Foque...... | 5.00 |
| " 10 | G. P. Fisher....... | 5.00 |
| " 10 | T. W. Newell..... | 5.00 |
| " 11 | B. Sinnott......... | 5.00 |
| " 18 | J. Harrison........ | 5.00 |
| " 25 | A. W. Twombly... | 5.00 |
| Mch. 2 | F. Hedley........ | 5.00 |
| | *Carried forward*... | $2,155.00 |

| | | |
|---|---|---|
| | *Brought forward*... | $2,155.00 |
| Mch. 3 | A. L. Humphrey... | 5.00 |
| " 4 | C. B. Hogsett...... | 5.00 |
| " 12 | J. Marchbanks..... | 5.00 |
| " 14 | A. C. Hinckley .... | 5.00 |
| " 16 | I. W. Fowle....... | 10.00 |
| " 17 | G. A. Ferguson .... | 5.00 |
| " 18 | M. K. Barnum..... | 5.00 |
| " 21 | J. O. Nicholas...... | 5.00 |
| " 24 | C. Skinner......... | 5.00 |
| " 25 | J. J. Sullivan....... | 5.00 |
| " 28 | W. A. Nettleton.... | 5.00 |
| " 30 | J. Lythgoe......... | 5.00 |
| April 4 | T. L. Chubb....... | 5 00 |
| " 4 | G. T. Neubert...... | 5.00 |
| " 8 | W. Hassman....... | 5.00 |
| " 15 | W. H. Marshall.... | 5 00 |
| " 15 | H. P. Robinson.... | 5.00 |
| " 18 | A. Hendee........ | 10.00 |
| " 18 | F. B. Miles....... | 5.00 |
| " 18 | E. M. Roberts..... | 10.00 |
| " 18 | E. Priest.......... | 5.00 |
| " 18 | W. Lavery ........ | 5.00 |
| " 19 | R. Tawse ......... | 10.00 |
| " 19 | W. I. Cooke....... | 5.00 |
| " 19 | H. M. Minto ...... | 5.00 |
| " 20 | F. W. Morse....... | 5.00 |
| " 20 | G. A. Bruce....... | 5.00 |
| " 20 | J. Campbell........ | 5.00 |
| " 20 | T. Walsh.......... | 5.00 |
| " 20 | G. S. McKee ...... | 10.00 |
| " 21 | A. B. Minton...... | 5.00 |
| " 21 | E. V. Sedgwick.... | 5.00 |
| " 21 | C. H. Burns ....... | 5.00 |
| " 23 | J. A. Quinn ....... | 5.00 |
| " 25 | W. H. Hudson .... | 10.00 |
| " 26 | J. Player.......... | 5.00 |
| " 27 | C. H. De Witt..... | 5.00 |
| " 28 | C. Lindstrom ...... | 5.00 |
| " 28 | J. C. Homer....... | 5.00 |
| " 28 | A. L. Moler ....... | 5.00 |
| " 29 | W. F. Dixon ...... | 5 00 |
| " 29 | F. F. Gaines....... | 5.00 |
| " 29 | G. W. Smith....... | 5.00 |
| " 30 | J. Bean........... | 5.00 |
| | *Carried forward*... | $2,405.00 |

| | | |
|---|---|---|
| | *Brought forward*... | $2,405.00 |
| April 30 | P. Ryan .......... | 5.00 |
| May 2 | H. C. Smith....... | 5.00 |
| " 2 | A. Santer ......... | 5.00 |
| " 2 | W. D. Holland .... | 5.00 |
| " 4 | A. H. Watts....... | 5.00 |
| " 4 | J. M. Dow........ | 5.00 |
| " 6 | H. D. Page........ | 5.00 |
| " 9 | W. Thow ......... | 5.00 |
| " 9 | W. Kelly.......... | 5.00 |
| " 9 | F. Slater.......... | 5.00 |
| " 10 | W. Buchanan...... | 5.00 |
| " 10 | George Lindoff..... | 5.00 |
| " 10 | F. W. Mahl ....... | 5.00 |
| " 11 | J. J. Casey........ | 5.00 |
| " 11 | A. S. Vogt........ | 5.00 |
| " 12 | T. B. Purves, Jr.... | 5.00 |
| " 16 | J. Howard ........ | 5.00 |
| " 16 | J. G. Clifford ...... | 5.00 |
| " 16 | F. H. Neward..... | 5.00 |
| " 17 | F. Rearden........ | 5.00 |
| " 17 | H. J. Rainsford.... | 5.00 |
| " 18 | J. Kennedy........ | 10.00 |
| " 18 | C. A. Ward........ | 5.00 |
| " 18 | J. S. Patterson ..... | 5.00 |
| " 19 | F. G. Lauer ....... | 5.00 |
| " 19 | J. N. Barr. ....... | 5.00 |
| " 19 | W. H. Stocks...... | 5.00 |
| " 19 | W. F. Bradley..... | 5.00 |
| " 20 | S. L. Bean ........ | 10.00 |
| " 20 | J. McDonough..... | 5.00 |
| " 20 | J. C. Slater........ | 5.00 |
| " 20 | G. F. Richards .... | 5.00 |
| " 20 | J. Hickey ......... | 15.00 |
| " 21 | J. Townsend....... | 5.00 |
| " 21 | J. Carr............ | 5.00 |
| " 23 | D. O'Leary........ | 10.00 |
| " 23 | J. L. Smith........ | 5.00 |
| " 23 | W. L. Tracy....... | 5.00 |
| " 23 | W. Montgomery.... | 5.00 |
| " 23 | C. Graham, Jr...... | 5.00 |
| " 24 | C. F. Ward........ | 5.00 |
| " 25 | J. M. Sheer ....... | 5.00 |
| " 25 | D. H. Dotterer .... | 10.00 |
| " 25 | L. H. Waugh...... | 5.00 |
| | *Carried forward*... | $2,655.00 |

| | | | |
|---|---|---|---|
| | | *Brought forwaad*... | $2,655.00 |
| May | 26 | G. D. Brooke...... | 10.00 |
| " | 26 | G. W. Gage....... | 5.00 |
| " | 28 | F. G. Brownell .... | 5.00 |
| " | 28 | A. F. Stewart...... | 10.00 |
| " | 28 | A. J. Beltz ........ | 5.00 |
| " | 28 | J. Billingham ...... | 5.00 |
| " | 31 | J. P. Bay.......... | 10.00 |
| " | 31 | R. Allin .......... | 5.00 |
| " | 31 | R. D. Wade....... | 5.00 |
| " | 31 | H. Monkhouse..... | 5.00 |
| | | *Carried forward*... | $2,720.00 |

| | | | |
|---|---|---|---|
| | | *Brought forward*... | $2,720.00 |
| June | 1 | H. T. Bruck....... | 5.00 |
| " | 1 | T. Thatcher ....... | 10.00 |
| " | 1 | J. F. Deems....... | 5.00 |
| " | 1 | M. Roberts........ | 5.00 |
| " | 1 | Z. T. Brantner .... | 10.00 |
| " | 2 | R. P. C. Sanderson. | 5.00 |
| " | 2 | C. Blackwell....... | 5.00 |
| " | 2 | C. F. Thomas...... | 5.00 |
| " | 3 | C. T. McElvaney... | 5.00 |
| " | 6 | L. H. Turner...... | 5.00 |
| | | *Total*.............. | $2,780.00 |

THE PRESIDENT: Gentlemen, you have heard the report of the Secretary. What is your pleasure to do with it?

MR. MACKENZIE: I move that it be received and take the usual course. (Seconded.)

THE PRESIDENT: It is moved and seconded that the report of the Secretary be received and ordered on file and printed in the proceedings.

The motion was carried.

THE PRESIDENT: Our Treasurer is not able to be with us, but he has forwarded a report which is in the hands of the Secretary, and I will ask him to read it.

Mr. Cloud read the Treasurer's report as follows:

TREASURER'S REPORT.

| | |
|---|---|
| Balance on hand as per last report.................................... | $1,659.01 |
| Amount received from Secretary since Convention in June, 1897........ | 555.12 |
| | $2,214.13 |
| Disbursements............. ............................................ | $ 0.00 |
| Balance on hand June 14, 1897 ........................................ | $2,214.13 |

Respectfully submitted,

J. N. BARR,
*Treasurer.*

THE PRESIDENT: Gentlemen, you have heard the report of our Treasurer. What is your pleasure to do with it?

MR. HENDERSON: I move that it be received. (Seconded.)

THE PRESIDENT: It is moved that the Treasurer's report be received and submitted to the Auditing Committee.

The motion was carried.

THE PRESIDENT: The next matter in hand is the assessment and announcement of annual dues. The Executive Committee at their last meeting recommended that the assessment remain the same as in the past, namely, $5 per member. What is your pleasure to do with the recommendation of the Executive Committee?

MR. GARSTANG: Mr. President, I move that the recommendation of the Executive Committee be placed in force this year, and that the dues remain the same as heretofore. (Seconded.)

THE PRESIDENT: It is moved and seconded that the recommendation of the Executive Committee that the assessment remain the same as heretofore, namely, $5 per member, be adopted.

The motion was carried.

THE PRESIDENT: Now, gentlemen, we have to elect an Auditing Committee. This election has to be by ballot unless it is voted by the Association to the contrary. I would like to hear from the Association as to whether we shall proceed by ballot or whether we shall nominate and elect by viva voce vote an Auditing Committee of three members.

MR. PECK: I move that they be nominated and elected by acclamation.

MR. MACKENZIE: I would like to amend that. I do not think that is in keeping with the Constitution. Therefore I would suggest that the members select the Auditing Committee and empower the Secretary to cast the ballot of the Association for such members as are selected.

MR. GARSTANG: I second that motion.

THE PRESIDENT: I think Mr. Peck's motion was not seconded, and Mr. Mackenzie's being seconded, we will vote on the motion as make by Mr. Mackenzie.

The motion was carried.

THE PRESIDENT: Please nominate.

MR. E. A. MILLER: I would nominate Mr. Mackenzie.

THE PRESIDENT: Gentlemen, as Mr. Mackenzie has been nominated, we will take a vote on his nomination as chairman of the Auditing Committee.

The motion to nominate Mr. Mackenzie as chairman of the Auditing Committee was carried.

MR. SINCLAIR: I nominate W. H. Marshall.

MR. MACKENZIE: I second the nomination.

The motion to nominate Mr. W. H. Marshall as a member of the committee was carried.

MR. MACKENZIE: I nominate A. M. Waitt.

MR. SINCLAIR: I second the nomination.

The motion to nominate Mr. Waitt as a member of the Auditing Committee was carried.

MR. SINCLAIR: Mr. President, I move that the Secretary be instructed to cast the ballot for those names. (Seconded.)

The motion was carried.

MR. CLOUD: The Auditing Committee is John Mackenzie (chairman), W. H. Marshall and A. M. Waitt. The papers, books, accounts, etc., can be found in the room of the Executive Committee and Secretary, Room 32, on the office floor of Congress Hall, at any time the committee wishes to examine them.

THE PRESIDENT: The next order of business is unfinished business. Mr. Secretary, have you any unfinished business?

MR. CLOUD: The proposition of last year to elect Mr. G. M. Basford as an associate member of this Association was referred to a committee which reported to the Executive Committee, and the Executive Committee has approved the candidacy.

THE PRESIDENT: Gentlemen, you have heard the recommendation of the committee appointed relative to the election of Mr. Basford as an associate member of this Association, also the approval of the Executive Committee. What is your pleasure to do with it?

MR. PECK: I move that the Secretary cast the ballot of this Association for Mr. Basford as associate member. (Seconded.)

MR. SINCLAIR: Mr. President, that has led several times to a great deal of embarrassment in the election of associate members, and it has been repeatedly decided that it was more in the line of the Constitution and much better for the Association that the members should cast their individual ballots for an associate member.

THE PRESIDENT: Did I hear a second to that motion? I think not. We will proceed to ballot on this application in the usual manner, and I will appoint Messrs. Mackenzie and Waitt as tellers.

THE PRESIDENT: The Secretary will read some notices to the convention while the balloting is going on.

MR. CLOUD: As there is no roll call, provision is made by means

of a box at the door for members to record themselves as present at least once. It is not necessary to deposit a card each day, but it is desirable that each member should deposit one card to record his presence.

MR. CLOUD: A note from Mr. Clement, of Congress Hall, says that the special rate made by Congress Hall to all the members and their families will hold good until July 6, in case any desire to remain after the convention in Saratoga is over. I have also the following:

The International Correspondence School, of Scranton, Pennsylvania, whose success in teaching the industrial sciences, and particularly mechanics and mechanical drawings, is probably known to you, will have a private car at Saratoga at the D. & H. station, June 15 to 23, 1898. Will be pleased to have you visit the car.

Signed by the president and the manager of the company.

*To the President and Members of the American Railway Master Mechanics' Association:*

The Lake Shore & Michigan Southern Railway Company desire to extend the courtesies of their road to any of the members of the Association who desire to return from the convention by that line. Any members who desire transportation over the Michigan Southern road for themselves or their families can obtain the same by applying to the undersigned prior to Tuesday noon.

A. M. WAITT, *General Master Car-Builder.*

MR. MACKENZIE: Mr. Chairman, the tellers are ready to report.

THE PRESIDENT: We will listen to the report of the tellers.

MR. MACKENZIE: Mr. Chairman, there have been eighty-seven votes cast, all of which are "yes." (Applause.)

THE PRESIDENT: There is another candidate for associate membership, and we will retain the same tellers, as they did pretty well this time.

MR. CLOUD: Mr. Edward C. Bates was proposed last year as an associate member. The Chair appointed a committee, and that committee reported to the Executive Committee, which has indorsed the candidacy.

THE PRESIDENT: Gentlemen, you have heard the recommendation of the committee and the approval of the Executive Committee, and we will proceed to ballot on the candidacy of Mr. Edward C. Bates for associate membership.

MR. FORNEY: There apparently is nothing before the Association at the present time while this vote is being taken, and I see our newly elected member, Mr. Basford, in the box on the right. I would suggest that he either make a speech or sing a song to the audience.

MR. BASFORD: Mr. President, I am sure that everybody in this audience would very much prefer to hear Mr. Forney, and I would be very happy to resign in his favor.

THE PRESIDENT: I think we will hear from Mr. Forney before we get through. If not, it will be an innovation and a disappointment. Have all voted who wish? If so, I declare the ballot closed.

MR. MACKENZIE: I want to say, with all due respect to Mr. Basford, that the tellers did not vote last time. So he ought to have had eighty-nine votes instead of eighty-seven.

THE PRESIDENT: Gentlemen, I think under the circumstances it would be proper for the Secretary to count that vote as eighty-nine, as I understand that both the tellers assure us that they would have voted "yes."

MR. MACKENZIE: Mr. Chairman, the tellers are ready to report.

THE PRESIDENT: Please listen to the announcement of the tellers.

MR. MACKENZIE: There are eighty-eight votes cast, of which eighty-five are "yes" and three "no."

THE PRESIDENT: I believe it takes five to reject, consequently the gentleman is elected. (Applause.)

THE PRESIDENT: Gentlemen, we will listen to some announcements from the Secretary before we proceed to new business, as this is all the unfinished business before us that I know of.

MR. CLOUD: The last item on the programme refers to a lecture to be given by Professor Goss of Purdue University on the "Training of an Engineer," illustrated by sixty stereopticon views. The hour has been fixed at 8:15, and the place in this hall. Mr. Schevers has tickets for reserved seats on the first floor, which are for members and their families, and he will distribute them among you when he has an opportunity.

THE PRESIDENT: Gentlemen, we have an invitation here from the Schenectady Locomotive Works, and I will ask the Secretary to read a letter which I wrote to him which embodies the invitation as I received it for the Association from the Schenectady Locomotive Works.

MR. CLOUD: The letter from Mr. Leeds, referred to, under date of June 6, is as follows:

I have a letter from Mr. A. J. Pitkin, vice-president and general manager of the Schenectady Locomotive Works, saying that it would give the Schenectady Loco-

tive Works great pleasure to have the Association visit their works at Schenectady on any day they may find most convenient for them. They state that arrangements will be made with the railway people to furnish transportation, and ask that we submit this invitation upon the opening of the first meeting of the Association, and if convenient advise them as early as possible the date and hour which they may select for such visit. Will you please submit this to the Association as requested?

THE PRESIDENT: Gentlemen, you have heard the invitation of the Schenectady Locomotive Works to visit their establishment at any day or hour, but the invitation from the railroad company, through Mr. Blackall, designates a definite time when the train shall leave. I understand, although I have no authority for saying it, that if the members will take this train at one o'clock they will find lunch prepared for them at Schenectady. It makes it obligatory, if we accept the invitation of the Schenectady Locomotive Works to visit them, that we set the time in accordance with the invitation of the railroad company. You have heard this invitation. What is your pleasure to do with it?

MR. BRANGS: I move that we accept the invitation. (Seconded.)

THE PRESIDENT: Gentlemen, you have heard the motion, which has been seconded, that we accept the invitation. May I ask the maker of that motion if he includes the proposal of the railroad company to furnish transportation? You understand that the invitation of the Schenectady Locomotive Works says any time, while the invitation of the railroad company says at one o'clock Tuesday. Does your motion include this invitation?

MR. BRANGS: Yes.

THE PRESIDENT: The motion is that we accept the invitation of the Schenectady Locomotive Works to visit their works, also to accept the offer of the railroad company to furnish a special train leaving here at one o'clock Tuesday, and also included in this invitation is that of the General Electric Company, of Schenectady. As many as are in favor will signify by saying "aye"— contrary minds, "no."

The motion was carried.

THE PRESIDENT: Our Secretary will notify them as soon as possible.

MR. PITKIN: I just came in, and I would say in this connection that we will give a light lunch so as to stay your appetites until you return in the evening. We will run the train down to the electric

works, and I think the gentlemen will all spend an enjoyable hour at the General Electric Company's Works.

THE PRESIDENT: I would like to impress on the gentlemen having this under their control that we are to have a lecture by Professor Goss, giving an exhibition of the student at work, and that in line with what I have outlined in the address, we are in hopes that such delineation will bring out an interest in such matters, and especially in regard to our boys. Consequently I will ask the gentlemen to be sure to get us back in plenty of time so that the ladies will have a little rest and we may be able to attend the so-called entertainment, which is, in my opinion, an instructive lecture.

MR. CLOUD: I wish that Messrs. Pitkin and Blackall would take this as official notice of the acceptance of the invitations.

MR. STEWART: I would like to inquire if this invitation includes the ladies?

MR. PITKIN: Most assuredly it does.

THE PRESIDENT: Does any member of the Association know of any further unfinished business? If not we will proceed to new business. Now, gentlemen, I have a request to make. As you have probably noticed, while I am not growing old, I have to use two pair of glasses, one for distance and one for reading, and it might be almost impossible for me to work the lightning change soon enough to decide as to who had the floor, and I will request as you rise to your feet you will announce your names. The fact is there are some new faces that I cannot immediately recognize. Furthermore, I want to say to you that as a parliamentarian I have not been on deck at all, and consequently I will have to ask of you that you do not undertake to spring any new questions of parliamentary ruling on me. [Laughter and applause.]

MR. CLOUD: The Chair requests me to say that now would be an appropriate time for Mr. Mackenzie's motion, which he sought to make immediately after the recess, in regard to a committee on the President's address.

MR. MACKENZIE: What I wanted to say, Mr. Chairman, was this: That it has been the practice of our presiding officers to suggest subjects for the consideration of this body, but so far as I have observed very little attention has ever been paid to them, and in view of the fact that recommendations have been made by the President, I move

that a committee be appointed to select such subjects as it thinks will meet with the approval of the Association and present them in writing.

MR. GARSTANG: I second that motion.

THE PRESIDENT: You have heard the motion as moved and seconded, and I will request the gentlemen to write it out at their leisure, inasmuch as it should be spread upon our minutes properly.

The motion was carried.

THE PRESIDENT: Now I will ask you to nominate such committee.

MR. MACKENZIE: I nominate Mr. J. H. Setchel.

MR. SETCHEL: I object, Mr. President. I have got through with committees.

THE PRESIDENT: It has been thoroughly discussed in the Executive Committee for several years past that Mr. J. H. Setchel was entitled to full honorary membership in this Association, and in every case it has been voted down, from the fact that we considered that we could not afford to lose him and that he should be entitled to a vote, and that he probably considered that worth more than it cost him. Now I most seriously object to Mr. Setchel withdrawing from committee work or in any way retiring from the active service of this Association. [Applause.]

MR. SETCHEL: Mr. President, I am very grateful for the complimentary remarks you have made, but I have been retired — not on any vote, but I have been retired, and I do not wish to be placed on any committees.

THE PRESIDENT: Then, on behalf of the Executive Committee, I would ask Mr. Setchel if he would accept an honorary membership if tendered to him?

MR. SETCHEL: We have a good many such memberships in this Association, and while I do not feel at liberty to decline, I do not want to deprive myself of having a voice if I see proper to use it.

THE PRESIDENT: Which is exactly the reason you were not made an honorary member several years ago, and I do not like the idea of your retiring. We have not retired you.

MR. MACKENZIE: Mr. Chairman, are we not a little bit off on this question? Mr. Setchel is a regular member of the Association.

THE PRESIDENT: He is an active member of the Association.

MR. MACKENZIE: Then I say he has no right to withdraw from this committee. The Association will decide whether he will serve or not. [Applause.]

THE PRESIDENT: Gentlemen, you have heard the nomination made and seconded that Mr. Setchel be made chairman of this committee. As many as are in favor will signify by saying "aye"—contrary minds, "no."

The motion was carried.

THE PRESIDENT: Mr. Setchel will act as chairman, regardless of his retirement. I would like to hear a second nomination.

MR. MCINTOSH: I nominate Mr. Peter H. Peck.

THE PRESIDENT: Mr. P. H. Peck is nominated as second member of this committee. As many as are in favor will signify by saying "aye"—contrary minds, "no."

The motion was carried.

MR. SETCHEL: I nominate Mr. A. M. Waitt, of the Lake Shore. (Seconded.)

THE PRESIDENT: It is moved and seconded that Mr. A. M. Waitt act as one of the committee. As many as are in favor will signify by saying "aye"—contrary minds, "no."

The motion was carried.

THE PRESIDENT: That, as I understand it, will fill the committee. Is there any other new business? There is something on the desk here, if you will listen to the Secretary.

MR. CLOUD: At the meeting of the Executive Committee held on Saturday, it was determined to recommend to the Association to elect Messrs. M. N. Forney, E. L. Coster and J. I. Kinsey as honorary members; the first two from the list of associate members, and the third from the list of active members.

THE PRESIDENT: You have heard the recommendation of the Executive Committee. What is your pleasure?

MR. PECK: I move that it be adopted. (Seconded.)

THE PRESIDENT: It is moved and seconded that the recommendation of the Executive Committee be adopted, that these two

associate members and one active member be elected honorary members.

The motion was carried.

MR. GENTRY: While under that head, we have a request here from Mr. James Maglenn, an old member of twenty years' standing in our Association, who has about retired from active business. He is with us this year for the first time in a long while. I would like to be instructed by the Secretary as to how to have his name brought before the Association for honorary membership.

MR. CLOUD: You can make a motion now to that effect.

MR. GENTRY: Then I make the motion. I think every old member in our Association knows Captain Maglenn. (Seconded.)

The motion was carried.

MR. CLOUD: I have a notice that members of the Master Mechanics' Association desiring return Pullman transportation can obtain the same by applying to H. M. Pflager, Chief Mechanical Inspector, Pullman Palace Car Company, who will be at Room 140, Grand Union Hotel, until Wednesday morning.

THE PRESIDENT: Gentlemen, I have asked once or twice if any one knew of any further new business.

MR. T. R. BROWNE: I think it will properly come under this heading—if it does not the President will call me down. The question of steel cars is one that all of us are more or less interested in at this time, and as it is comparatively a new question and their life is something that we do not all know a great deal about, I thought it might be well to bring up the question again. If I have been informed rightly, a committee was appointed some time ago, and it advocated that the question be put off for report for about four years. It seems to me that it would be a very good thing if a committee were in action for that four years, although it might not make its final report until the end of the four years, for the reason that those cars are showing evidence one way or the other of their efficiency or otherwise, and the continued investigation on the part of this committee would make that report more valuable as a record of the four years' service on those cars. I saw two of those cars that had been in a wreck about three weeks ago, and the evidence at that time seemed to point to less total repairs to those cars, but a kind of repairs that would

require other kinds of equipment to keep them up than what the average car shop is provided with.

THE PRESIDENT: I will have to call the gentleman to order, inasmuch as I do not consider that that is really new business. At any rate it is a business that should be introduced to the Association through its Committee on Subjects, as it is a matter that would have to be taken up as a subject and a committee appointed on it; and whilst it is very interesting, I do not know that we have ever had a committee on that subject. Any further new business? If not, we will pass to the reports of committees. The first one is on "Tonnage Rating for Locomotives," Mr. G. R. Henderson, chairman. I will respectfully ask him to come on the platform, as I find the audience can hear a great deal better from the platform than from the floor.

Mr. Henderson read the following report:

## REPORT OF COMMITTEE ON TONNAGE RATING FOR LOCOMOTIVES.

*To the President and Members of the*
*American Railway Master Mechanics' Association:*

When your committee was instructed to report on the subject of Tonnage Rating, it appreciated the fact that a large "contract" had been awarded it — one that could not be completely discussed in all its many and varied phases without a great deal of labor, and the production of an essay far too voluminous for such an occasion as the Master Mechanics' convention, and your committee feels that much has been omitted in the following paper which might have been included with advantage; but, as the chairman was not able to secure any help or co-operation from the other members of the committee, it is hoped that some indulgence will be granted by the Association for its shortcomings.

In order to determine the value and success of the tonnage method of rating locomotives in comparison with other methods of making up trains, a circular was sent out, under date of October 5, 1897, asking for definite information on this point. Forty-three roads in the United States, Canada and Mexico, operating over 66,000 miles of track, reported that they were using the tonnage method; some had been working this way for fifteen years, and some for only three months, with an average for all the roads of possibly two years, but the advantages derived were all of the same order, and may be comprehended, generally, by the following statement:

Heavier average trains hauled with less stalling; more uniform loads and better condition of engines, particularly the tubes, on account of not being overloaded; less engine and more car mileage; less friction between Motive Power and Transportation Departments, and more satisfactory results in every way.

Various estimates of the increase in trains handled under this method were given, which ranged from 10 per cent to 43 per cent, but it is probable that the aver-

age will fall between 10 and 20 per cent. The figures, too, came from every variety of road, from the level and straight shore roads, and the undulating prairie roads, to the crooked mountain lines of the Appalachian and the Rocky ranges.

One of the first questions which arise when the desire to adopt the tonnage method of rating has aroused us is, how to obtain the proper rating for the different engines on the various portions of the road. The practical method naturally suggests itself first; that is, try it for each class of engine on each critical or controlling part of the division and keep on trying to see what can be pulled, till you reach the limit. While this method has been used on twenty-two of the lines reporting, yet we believe that results can generally be secured more quickly and satisfactorily by first producing the theoretical rating and then checking these figures by actual trials under various conditions of weather, etc. Fourteen roads have handled the subject in this way, while six have been content with a theoretical rating alone.

### EXPERIMENTAL DETERMINATIONS.

On the Burlington & Missouri River Railroad in Nebraska, the tonnage ratings were determined by actual trials with weighed trains, on the ruling grades, with usually but one class of engine, and from these results the ratings for other classes were determined. After about a year's trial, these ratings were revised in the light of experience, and with but one or two minor exceptions, the original ratings were increased. Perhaps the most elaborate preparations were made by the Southern Pacific Company, and we reproduce a large portion of the circular issued on this subject, in April, 1897—it is so complete that comment on it seems unnecessary:

"To insure uniformity in conducting experiments to determine tonnage rating of locomotives, the following instructions should be observed as closely as possible:

"1. Locomotives on each division should be divided into classes or groups, and a representative locomotive from each class or group selected for experimenting. These representative locomotives should be weighed, with coal and water, ready for service.

"2. A sufficient number of fully loaded cars, preferably of 25 or 30 tons capacity, should be selected. Shipments of company freight, such as coal, rails or gravel, are very convenient for this purpose, the experiments on the Western Division having been conducted with fifty 30-ton box cars fully loaded with coal.

"A list should be prepared showing the position by number of each car in train, counting from both head and rear end, the initial and number of each car, the gross weight as well as the gross weight of the train up to and including the weight of each car, counting from both front and rear end, being shown as exemplified in the list below:

| Initial of Car. | Number of Car. | Weight of Car. "Ms." | Order of Cars and Weight of Train from Head End. | | Order of Cars and Weight of Train from Rear End. | |
|---|---|---|---|---|---|---|
| | | | No. | Weight. | No. | Weight. |
| S. P. | 72186 | 94 | 1 | 94 | 10 | 870 |
| S. P. | 66193 | 84 | 2 | 178 | 9 | 776 |
| C. P | 69730 | 88 | 3 | 266 | 8 | 692 |
| S. P. | 65072 | 87 | 4 | 353 | 7 | 604 |
| Cal. P | 70974 | 88 | 5 | 441 | 6 | 517 |
| S. P. | 68599 | 84 | 6 | 525 | 5 | 429 |
| S. P. | 61039 | 86 | 7 | 611 | 4 | 345 |
| S. P. | 66164 | 89 | 8 | 700 | 3 | 259 |
| C. P | 69838 | 85 | 9 | 785 | 2 | 170 |
| S. P. | 66211 | 85 | 10 | 870 | 1 | 85 |

Note.—Weight shown to nearest "M" or 1,000 pounds.

"3. To establish the rating or hauling capacity of the different classes or groups of locomotives, one of each class or group, together with the cars constituting the test train, should be assembled at some convenient point on the division, preferably where the grade is very light or on a level, the tests being made under exactly the same conditions for the different engines. In starting a test, the hauling capacity of a locomotive is estimated. It starts with its train and another locomotive follows, by which the number of cars is increased or diminished in such a manner as to keep the locomotive being tested up to its full hauling capacity.

"4. Having determined, as indicated in paragraph 3, the hauling capacity of each class or group of locomotives on a given part of the division, it is necessary to supplement these experiments with others to determine the hauling capacity of each class or group of locomotives on all other parts of the division. To determine the relative resistance on other parts of the division in comparison with the resistance on that part of the division assumed as a standard in paragraph 3, it is not necessary to test each and every class or group of engine on each and every part of the division. Two locomotives of the same class are selected and, with one of these on each end of the test train, headed in opposite directions, the same cars in the same order as used in the first tests are hauled over the entire length of the division. The object in heading the engines in opposite directions is in order that the resistance of grades on both sides of a summit may be determined, either engine acting, as the case may be, as an assistant or following engine to the other. With these two locomotives and test train, the hauling capacity of the class of locomotives to which the two belong is determined for all parts of the division. Attention should be given to particularly hard pulls in getting out of sidings, or pulling out of stations on grades, etc. It should, however, be borne in mind that, on short grades where helpers are used or on grades that are commonly doubled, it will not be necessary to make experiments, as such grades are not the limiting ones for the power on that division. The tests should be made only at places where a single engine handles the entire train. From the data furnished the mechanical engineer, the rating of locomotives in other classes or groups can be raised or lowered for any given part of the division in the same ratio as the rating of the particular engines used in the tests was raised or lowered.

"5. Wherever practicable to do so, tests should be made in two ways: firstly, to determine the maximum load with which the locomotive can start; and, secondly, to

determine the load that can be ordinarily taken over a grade when it is approached at ordinary speed.

"6. Tests on each division should be numbered consecutively, commencing with No. 1. It is desired that the report of these tests be made as complete as possible, and in the form indicated by sample Western Division reports shown below:

"*Western Division Test No. 25, February 18, 1897.*

"Standing test on grade between east switch at Decoto and top of grade west of Decoto, west-bound. Engine 1580, headed west; head car, S. P. 72461; rear car, C. P. 73871.

"Starts were made with rear car at east switch at Decoto. Started at 7:30 A. M., with the last 24 cars on list, weighing 1,124 tons. Engine passed over grade at 7:14½ A. M. This was the fourth start, the three previous starts being made with the last 30, 28 and 26 cars, respectively. Total weight of train hauled: Engine and tender, 74 tons; last 24 cars on list, 1,124 tons; total, 1,198 tons.

"Remarks: When this test was made it was raining very hard. It is the opinion that, under these conditions, a load of 1,198 tons is the limit for effective service for a standing test from Niles to Decoto, west-bound.

"*Western Division Test No. 30, February 18, 1897.*

"Running test between Niles and top of grade west of Decoto, west-bound. Engine 1580, headed west; head car, S. P. 72461; rear car, C. P. caboose 12. Left Niles at 11:52 A. M. with last 38 cars and caboose, weighing 1,748 tons. Engine passed depot at Decoto at 11:57 A. M., speed about 18 miles per hour. Engine passed over the grade at 11:59 A. M. Total weight of train hauled: Engine and tender, 74 tons; last 38 cars and caboose, 1,748 tons; total, 1,822 tons.

"Remarks: This test was made under favorable conditions as to rail, wind and weather. It is the opinion that, under these conditions, a load of 1,822 tons is the limit for effective service for a running test from Niles to Decoto, west-bound.

"7. In making tests on the Western Division with either end of the train, it was deemed best, to insure uniformity as well as to avoid error in recording weights, to call the east car or one farthest from San Francisco the first car, and the west car or one nearest to San Francisco the last car in the train. In making tests with the east engine, the number of cars in the train was counted from east to west and recorded as first — cars on the list; in making tests with the west engine, the number of cars in the train was counted from west to east and recorded as the last — cars on the list. It will be found advantageous not to disturb the order of cars in the train after the experiments have commenced, as thereby errors in recording the weights of train may be avoided.

"8. Accompanying the reports to the mechanical engineer should be statements showing the initial and number of each locomotive in each class or group, as well as the initial and number of the representative locomotive selected from each class or group.

"9. The mechanical engineer will establish, by means of experiments made on the Western or Sacramento divisions, the relative resistance of empty and loaded cars, and the results will be sent you in due time, showing the allowance to be made in

rating for each empty car hauled, as it is obvious that a weight somewhat in excess of its actual weight must be assumed in rating locomotives; for an engine that will haul 2,000 tons of fully loaded cars of 30 tons capacity cannot haul 2,000 tons of empty freight cars."

From this information, which was sent from the various divisions, the final rating was determined.

### THEORETICAL DETERMINATION.

We have stated above that it is our opinion that the theoretical rating will be of great advantage in inaugurating tonnage rating, but to gain the greatest benefits from it, it is necessary that it be fairly accurate in defining the work for different locomotives and localities. We will now attempt to show how the rating may be determined in advance of the trials, or even the completion of the road, provided the profile and alignment can be obtained. Mr. Tweedy, Chief Engineer, Wisconsin Central Lines, who has been much interested in the subject, says: "I am convinced that if someone would take sufficient time and pay enough attention to the matter, that it would not be very hard to get up a table that would be so accurate that every part of a road could be rated theoretically in the office from the track profile, and in such a manner that the results would be practically satisfactory."

We will first enumerate the several factors which must be considered in producing the theoretical rating:

Power of the locomotive.
Adhesion of the locomotive.
Resistance of trains.
Value of momentum.
Effect of empty cars.
Effect of weather and seasons.

### POWER OF THE LOCOMOTIVE.

The starting point in all locomotive ratings is the power of the machine. The report of last year's Committee on Grate Area and Heating Surface, under the heading "Tractive Force," gave formulæ for making these calculations, and Diagram No. 2 gave information regarding the mean effective pressure. It will possibly be more convenient for our present purposes to put this formula in a slightly different form.

At slow speeds, say 50 to 75 revolutions per minute, with reverse lever in corner and a cut-off of 90 per cent (which is common among freight engines), we may consider that:

| | | | |
|---|---|---|---|
| Initial pressure.............. | = | .95 | boiler pressure. |
| Mean effective pressure ...... | = | .91 | initial pressure. |
| Mean effective pressure ...... | = | .86 | boiler pressure. |
| Allowing 8 per cent for friction | = | .92 | M. E. P. |
| Mean available pressure...... | = | .80 | boiler pressure. |

The value ".91" is obtained from Diagram No. 2 of the report above mentioned. Wellington ("Railway Location," page 531) thinks 8 per cent sufficient for internal friction. The result 80 per cent boiler pressure agrees with figures assumed by the

Baldwin Locomotive Works on page 87 of their new catalogue of narrow gauge locomotives, for working at slow speeds. The maximum speed at which these figures will apply is probably seven miles an hour for 50-inch wheels, eight miles an hour for 55-inch and nine miles for 60-inch wheels.

From the mean available pressure, the tractive force may be computed by this ormula:

$$\frac{p\ d^2\ s}{D} = \text{Tractive force in pounds.} \qquad (1.)$$

Where $p$ = Mean available pressure in pounds per square inch.
$d$ = Diameter of cylinder in inches.
$s$ = Stroke in inches.
$D$ = Diameter of driving wheels in inches.

This is clear of friction and represents the force exerted at the rails. Of course, the resistance of locomotive and tender must be deducted to get the net pull-back of tender.

We have stated above that the maximum tractive force could only be obtained at slow speeds — it is obvious that the boiler is totally insufficient to supply the quantity of steam for this force at high speeds. It will, therefore, be necessary to determine approximately the maximum tractive force at various speeds of which the engine is capable. If we assume that the grate area and heating surface have the values assigned by the committee last year, viz.: three times the total cylinder volume for grate area, and 200 times for heating surface, in bituminous coal-burning engines, the units being square and cubic feet (page 230, M. M. Report for 1897), and the maximum rate of combustion to be 160 pounds per square foot grate area per hour, which gives 2.4 pounds per square foot heating surface per hour, we should have (from Diagram No. 4 of previous report) an evaporation of six pounds water per pound of coal, from and at 212 degrees. This would give us:

$3\ V \times 160 \times 6 = 2{,}880\ V =$ pounds water evaporated per hour from and at 212 degrees, where $V =$ total cylinder volume in cubic feet.

From Formula 4 (page 227), by substituting $X$ for cut-off and $Y$ for revolutions, we have: $V \times X \times 2 \times Y \times .284 \times 1.2 \times 1.25 \times 60 = 2{,}880\ V$ or

$$X\ Y = \frac{2{,}880}{2 \times .284 \times 1.2 \times 1.25 \times 60} = 56.33, \qquad (2.)$$

which is the equation of an equilateral hyperbola.

Diagram No. 2 shows this line marked A–B, in which the ordinates give the cut-off and the abscissæ the revolutions per minute. This curve will be understood as showing the longest cut-off for which the boiler will furnish steam at the various speeds.

By means of Diagram No. 2 (last year's report), we can construct the line C–D, which shows the mean available pressure which may be expected at each speed.

With the ordinates multiplied by boiler pressure to represent the value of $p$ in Equation 1, the maximum tractive force at any speed may be approximately found.

The series of points X, X, show the values assumed for this maximum pressure by the Schenectady Locomotive Works on page 222 of their catalogue of 1897, when the stroke is 24 inches. Of course, differences in proportions of locomotives and valve gears will vary the power somewhat.

ADHESION OF THE LOCOMOTIVE.

The Master Mechanics' committee in 1887 recommended for freight engines, $\frac{P\,d^2\,s}{D} = .26\,W$, $P$ being the boiler pressure, or with a mean effective pressure of $.86\,P = p$, $\frac{p\,d^2\,s}{D} = .22\,W$, where $W =$ weight on drivers, or coefficient of adhesion taken at 22 per cent. (This is the figure adopted in last year's report.) Recently, locomotives with pneumatic sanders have given satisfactory service where $\frac{P\,d^2\,s}{D} = .31\,W$, or for $p = .86\,P$, $\frac{p\,d^2\,s}{D} = .27\,W$, or omitting effect of angularity of connecting rod and considering $p = .80\,P$, so as to include friction, we have $\frac{p\,d^2\,s}{D} = .25\,W$, or adhesion at 25 per cent.

Baldwin Locomotive Works Catalogue of 1897 (page 88), and Wellington's "Railway Location" (page 437), state that under favorable conditions 25 per cent adhesion may be realized, but that in winter and under general conditions the adhesion may amount to only 20 to 22½ per cent; we can, therefore, consider that the adhesion will be ordinarily 25 per cent with good sanding apparatus, and about 21 per cent without such apparatus, so that $\frac{p\,d^2\,s}{D}$ should be $=$ or $< .25\,W$ or $.21\,W$, respectively, where $p = 80$ per cent of the boiler pressure in order not to slip the drivers at slow speed.

RESISTANCE OF TRAINS.

Diagram No. 1, reproduced from last year's report on Cylinder Volume, Grate Area, etc., gives the probable resistance of trains due to speed, grade, curvature and acceleration, and your committee sees no necessity for making any changes in this chart. A grade will generally have some curves upon it, and, if sharp, these may constitute a critical or stalling point for heavy trains. The allowance for curvature will, of course, give the power necessary to pass such points, but generally in calculating the load for a locomotive the curvature function may be omitted or reduced to a general average, as in passing through a curve a small loss of velocity will afford sufficient force to take the train around it. So, also, the *average* grade should generally be taken instead of the *maximum*, if the latter occurs in short stretches, where the same small loss in velocity would help the trains over. If there is to be much variation in the speed, the coefficient for this feature should be modified accordingly. Page 544 of Wellington's "Railway Location" gives some interesting tables on this subject.

MOMENTUM.

While in mountainous regions, with long, heavy grades, there is little opportunity to take advantage of the force due to momentum, in undulating portions it may be utilized with the greatest advantage. A velocity of approach to a grade, when it can be reduced in ascending the grade, enables the engine to haul greater loads than it could without such assistance. This is well illustrated on the Norfolk Division of the Norfolk & Western. The grade out of Petersburg, going east, is thirty-seven feet and is about four miles long. As all trains stop at Petersburg, they are not able

to get the benefit of momentum, and a helper is necessary to get over the hill; the summit being passed, the helper returns. A few miles farther, the same grade exists — 8,000 feet long — but at this point a preceding down grade enables them to obtain sufficient velocity to pull the train up with one engine that at Petersburg required two. This illustrates how stops, crossings, curves, water tanks, etc., will interfere with the make-up of a train, if so located as to prevent the use of momentum, and it is necessary to bear all these points in mind when figuring the rating for an undulating division. Many railway officers contend that the gain from momentum cannot be figured, and while it is difficult to arrive at very accurate figures, yet we think that a fair degree of success may be obtained by carefully considering the various factors in the case.

Wellington, on page 335, gives a table of the velocity head for different speeds, which is the theoretical height which the train would be raised by that speed, and on page 347 he describes how a virtual profile can be constructed for the purpose of engine rating, instead of the actual profile, and which will include the benefits of momentum. We illustrate this by Diagram No. 3, which shows a small portion of the Wisconsin Central Lines, giving the virtual grades as obtained by variations in velocity, and which was furnished by Mr. Tweedy, Chief Engineer. The shaded portion shows the actual profile, while the solid line just above gives the virtual profile obtained by the variations in velocity indicated by the upper diagram.

The ordinary method of allowing for momentum is to deduct the velocity head from the total ascent (or really the difference between the initial and final velocity heads) and consider the grade easier by that amount. To illustrate, we may quote from a paper of Mr. H. H. Vaughan, read before the Northwestern Railway Club in December, 1895:

"Suppose, for example, that 5,000 feet of 1 per cent grade were so situated that trains could approach it at speed. The total rise of the grade would be 50 feet, but of that 15 feet could be overcome by the energy of the train, leaving 35 feet that the train must be raised by the engine. A grade in which the rise was 35 feet in 5,000 would be a 0.7 per cent grade, so that if the engine could exert sufficient force to overcome the train resistance and that due to a 0.7 per cent grade, the train could be lifted the remainder of the height by its kinetic energy. In this case the 5,000 feet of 1 per cent grade could be replaced by 5,000 feet of 0.7 per cent grade, and the effect on the load hauled by the engine would be the same, if in the latter case the energy of the train were not taken into account. Since the height to which the kinetic energy raises the train is independent of the length of the grade, its effect becomes far less when the grades are long than when short. Thus, for 1 per cent grade 1,000 feet long, since the total rise is only 10 feet, the kinetic energy would be more than sufficient to raise the weight of the train up the entire grade, leaving only the frictional resistances to be overcome by the engine; whereas, if the grade were 50,000 feet in length, or a total rise of 500 feet, the energy of the train would only reduce this by 15 feet, leaving 485 feet or the equivalent of a 0.99 per cent grade to be overcome by the engine, a reduction not worth considering."

It is thus seen that the length of grade exerts a great influence upon the value of momentum. Mr. Vaughan advises that no allowance be made when the total rise of the grade exceeds 100 to 120 feet.

The above method of figuring is open to one objection. Wellington (page 352) says that this method is deceptive because the power of the engine is materially greater at slow speeds than at high ones. This has been illustrated by Diagram No. 2, and is referred to further on by Mr. Vaughan in his paper. Your committee thinks that this objection may be overcome by the following method of considering the subject:

Let $t = \frac{\textit{tractive force in pounds}}{\textit{weight of train in tons}}$. This will vary from $t_{max}$ at slow speeds to $t_{min}$ at high speeds, or for variable speeds may be represented by $t_{avg}$ if based on the average tractive force for the speeds included; $y_4 =$ effect of momentum $= \frac{2.15 V^2 \times 2000 \times 1.05}{2 \times S \times 32.2} = \frac{70 V^2}{S}$, which is taken from the formula for $y_4$ on page 220 of last year's report, modified to include the inertia of the wheels, and in which $V =$ the speed in miles per hour and $S =$ space traversed in feet; $y_1 =$ resistance of train due to speed or $y_{avg}$ the average resistance when the speed varies; $y_2 =$ resistance due to grade.

The above functions give values in pounds per ton of load, and are taken from last year's report.

Now, it is evident that in a momentum run up a hill, with the engine exerting its utmost tractive power, that these two factors must overcome the resistance due to grade and speed.

In Diagram No. 4 let us call $A\ B$ the distance up the hill, or space "$S$". Then if the resistance due to grade $y_2$ be equal to $A\ G$, the work done overcoming this resistance will be represented by the area $A\ B\ H\ G$.

The variable resistance due to speed, varying from $G\ D$ at foot of grade to $H\ C$ at the top, will be represented by the area $G\ H\ C\ D$. The total work to be done ascending the grade is therefore evidently represented by the area $A\ B\ C\ D$, and $y_{avg} = \frac{G\ D + H\ C}{2}$. To accomplish this work, we have the variable power of the locomotive, varying from $A\ J$ to $B\ I$, or $t_{avg} = \frac{A\ J + B\ I}{2}$, and the work done by the engine will be represented by the area $A\ B\ I\ J$. We are still short the amount of work represented by the area $J\ I\ C\ D$ and this is to be supplied by the momentum. We can construct the parallelogram $J\ I\ F\ E$ equal in area to the trapezoid $J\ I\ C\ D$, which will represent the work to be done by momentum, so that the total area $A\ B\ F\ E$ will equal the area $A\ B\ C\ D$, or an equal quantity of work done and absorbed.

Now, as $A\ G = y_2$, $J\ E = y_4$, $\frac{G\ D + H\ C}{2} = y_{avg}$ and $\frac{A\ J + B\ I}{2} = t_{avg}$, we can write, from the equal areas $(y_2 + y_{avg})\ S = (y_4 + t_{avg})\ S$ or $y_2 + y_{avg} = y_4 + t_{avg}$, and substituting for $y_4$ its value, $\frac{70 V^2}{S}$, we have:

$$S = \frac{70 V^2}{y_2 + y_{avg} - t_{avg}} \qquad (3)$$

and as $t_{avg} = \frac{\textit{average tractive force}}{\textit{weight of train}}$, we have weight of train in

$$\text{tons} = \frac{\textit{average tractive force in pounds}}{y_2 + y_{avg} - \frac{70 V^2}{S}} \qquad (4)$$

By substituting o for any of these quantities, $y_2$, $y_4$, $y_{avg}$ or $t_{avg}$, the equations will give rational results for such cases where these factors are not present.

The above formulæ indicate that the greater the velocity, the greater will be the load or distance overcome on the grade, but, of course, there must be a limit to the maximum velocity. Wellington indicates that thirty miles an hour should be this limit, but we all know that thirty-five miles is nearer the limit when the alignment and other circumstances do not prevent making "a good run at a hill." In fact, we know of some cases where forty or forty-five miles an hour are reached, the track being straight and no crossings or stops interfering. This illustrates the importance of avoiding curves, water tanks, etc., at the bottom of "dips." In Formulæ 3 and 4, extreme accuracy would require substituting the difference of the squares of the initial and final velocities for the initial velocity $V$ only, but as the final speed is small, it will be sufficiently accurate to use the initial velocity only, when we consider the train just making the summit. The values of $y_{avg}$ and $t_{avg}$ may be obtained directly from Diagram No. 5.

EXAMPLES.

Before considering the effects of empty cars and weather, it will be interesting to find out how our assumptions and formulæ agree with the practical results. We will consider first the simpler cases of continuous grades, as exemplified by replies to our letter.

On the Sacramento Division of the Southern Pacific, 12-wheel engines, with cylinders 22 x 26 inches, wheels 55 inches diameter and boiler pressure 180 pounds, and a total weight of engine and tender of 133 tons, operate with ¾ cut-off and at a speed of twelve miles per hour, or seventy-five revolutions per minute, on grades of 116 feet per mile for a distance of forty miles. The curvature runs up to 10 degrees, so we will assume an average of 6 degrees.

From Diagram No. 2, the M. E. P. (allowing for friction) = 133 pounds, and therefore tractive force = 28,500 pounds. The resistance is made up as follows:

| | | | |
|---|---|---|---|
| Speed (12 miles per hour) | $= y_1 =$ | 5.5 | pounds per ton. |
| Grade (116 feet per mile) | $= y_2 =$ | 43.5 | " " |
| Curvature (6 degrees) | $= y_3 =$ | 5 | " " |
| Total resistance, | | 54 | " " |

Now, $\frac{28,500}{54} = 528$ tons, and subtracting weight of engine and tender, $528 - 133 =$ 395 tons net. The scheduled rating for this section is 400 tons. On a 106-foot grade the same engines are rated at 450 tons. $y_1 = 5.5 + y_2 = 40 + y_3 = 5 =$ 50.5 resistance, and $28,500 \div 50.5 - 133 = 431$ tons. On the Shasta Division, 19 x 30 inch Consolidation engines, with 51-inch drivers and 150 pounds steam, having a total weight of 98 tons, and a speed of twelve miles or eighty revolutions, haul 525 tons on a 67-foot grade, 310 on a 116-foot grade and 220 tons on a 174-foot grade. The formula gives

for the first case $22,200 \div 35.5 - 98 = 527$ tons,
for the second case $22,200 \div 54 - 98 = 313$ tons,
and for the third case $22,200 \div 73.5 - 98 = 204$ tons.

The curvature having been assumed to average 3 degrees in the last case, and 6 degrees in the first two.

On the Great Northern, allowing 80 per cent boiler pressure and an average of 5 degrees curvature on a 116-foot grade, we have, by calculation, 402 tons for Mastodon and 364 tons for Consolidation engines. The actual loading is 410 and 370 tons, respectively.

On the Norfolk & Western Railway, Blue Ridge Hill, a 61-foot grade, with curvature averaging, say 3 degrees, Class G engines (23,000 pounds tractive power), we have 23,000 ÷ 30 — 105 = 665 tons, actual load 645 tons; Class F engines (21,100 pounds tractive power), 21,100 ÷ 30 — 98 = 605 tons, actual load 615 tons. On the Norfolk Division, a 29-foot grade with straight track, we have:

Class G engine, 23,000 ÷ 16 — 105 = 1,335, actual 1,335 tons.
Class F engine, 21,100 ÷ 16 — 98 = 1,222, actual 1,275 tons.

On the Shenandoah Division, grades of 79 feet, we have:

Class G engine, 23,000 ÷ 35 — 105 = 552 tons, actual 530 tons.
Class F engine, 21,100 ÷ 35 — 98 = 505 tons, actual 510 tons.

On the Pocahontas and Clinch Valley Divisions, where occur the heaviest grades (106 feet per mile), the rating was figured out in accordance with Formula 2 in last year's report, the value of $p$ having been carefully deduced from some diagrams. The theoretical rating is here strictly adhered to, with very satisfactory results.

Let us now see what we find on undulating and level portions of roads. The Lake Shore & Michigan Southern is practically level and straight. A locomotive with cylinders 17 x 24 inches, 56-inch wheels, 162 pounds steam pressure and weighing, with tender, 90 tons, hauls 1,132 tons at an average speed of eighteen miles per hour. The maximum grade is 16 feet per mile, and at eighteen miles speed (one hundred and eight revolutions) the *M. E. P.* = 94 and the tractive force 11,600.

Adding the weight of engine and tender, we have 1,222 tons hauled, or 11,600 ÷ 1,222 = 9.5 pounds per ton, and as the resistance due to the grade = 6 pounds, we have 9.5 — 6 = 3.5 for speed, and as the average resistance will be 5½ pounds per ton, and the hill is 12,000 feet long, we will need 5.5 — 3.5 = 2 pounds per ton from momentum, or $y_4 = 2 = \frac{70V^2}{S}$ and $V = \sqrt{\frac{2 \times S =}{70}} \sqrt{\frac{2 \times 12{,}000}{70}} = 19$ miles per hour. As the tractive force increases as the speed diminishes, however, the real speed will be slightly lower.

On one of the undulating divisions of the Chicago, Burlington & Quincy, a Class H engine (19 x 24 x 64 inch wheels and 180 pounds steam), weighing 100 tons complete, hauls 1,300 tons up a 37-foot grade 10,000 feet long. At five miles per hour, and with the maximum tractive force, 19,500 pounds (at 80 per cent of 180 pounds), the load would be = 19,500 ÷ 19 — 100 = 926 tons, but if in Formula No. 4 we substitute for $\frac{Avg.\ T.\ F.}{y_2 + y_{avg} - \frac{70V^2}{S}}$ the values $\frac{\frac{6}{8} \times 19{,}500}{14 + 7.5 - \frac{70 \times 40^2}{10{,}000}} = 1420$, we have, after deducting weight of engine and tender, 1,420 — 100 = 1,320 tons, which would indicate that a high speed is necessary for this point. A similar grade (above referred to) on the Norfolk & Western 8,000 feet long is overcome by running at a corresponding speed, the calculations being about as above, where a 20 x 24 x 50 inch wheel

engine hauls 1,750 tons. By the general method ot allowing the full velocity head, and not considering the reduced tractive power at high speeds, calculations would argue a load of 6,300 tons for this point, at the speed mentioned.

Mr. R. P. Tweedy, Chief Engineer, Wisconsin Central Lines, has gone very thoroughly into this subject, and has prepared elaborate tables to show how many feet a train will run on various grades and with various loads by the assistance of momentum at various speeds. We wish to acknowledge much interesting information furnished by him on this subject.

### EFFECT OF EMPTY CARS.

Wellington considers that the resistance per ton for empty cars varies from 30 to 40 per cent more than that of loaded cars, on a level. Experiments on the Chicago, Burlington & Quincy showed about 50 per cent more resistance on a level and about 7 per cent more on a 30-foot grade. The location of loaded cars in a mixed train did not seem to materially affect the results.

Some recent experiments on level roads seemed to indicate that the resistance per car was nearly equal for empties and loads, but we do not believe that this would generally apply.

In response to Question 7 of our circular, a great variety of answers was obtained. Sixteen roads reported making no allowance for empty cars. This may mean, in some cases, that the traffic is largely in one direction, and that there are not enough empties to load engines to their capacity when returning the cars. One road allows 8 per cent excess, 3 roads 10 per cent, 2 roads 25 per cent; one road 5 tons, and one road assumes that they weigh 13 tons each. We also see allowances of 3 empties to 2 loads, 2 to 1, 5 to 2, 5 to 3 and 6 to 5.

Mr. McHenry, Chief Engineer of the Northern Pacific, has provided a triangular chart which covers empty, partly loaded and fully loaded cars, but each rate of grade requires a separate chart. Mr. Tracy Lyon, Master Mechanic of the Chicago Great Western, has formulated another, which requires a special line or locus for each class of engine. Both of these were recently illustrated in a paper read by Mr. L. R. Pomeroy before the New York Railroad Club, January 20, 1898.

The Mexican Central Railroad arranges for empties and partial loads in a somewhat different manner, by allowing a different rating, dependent upon the total number of cars in train. A couple of examples will illustrate this method:

LOCOMOTIVE, CLASS F.

| SANTA MARIA TO LOS SALAS. | | LECHERIA TO MEXICO. | |
|---|---|---|---|
| RULING GRADE, 1.25 PER CENT. | | RULING GRADE, 1.50 PER CENT. | |
| CARS. | KILOS. | CARS. | KILOS. |
| 9 | 310,000 | 7 | 260,000 |
| 10 | 303,000 | 8 | 253,000 |
| 11 | 296,000 | 9 | 246,000 |
| 12 | 289,000 | 10 | 239,000 |
| 13 | 282,000 | 11 | 232,000 |
| 14 | 275,000 | 12 | 225,000 |
| 15 | 268,000 | 13 | 218,000 |
| 16 | 261,000 | 14 | 211,000 |
| 17 | 254,000 | 15 | 204,000 |
| 18 | 247,000 | | |
| 19 | 240,000 | | |
| 20 | 233,000 | | |

Mr. Lyon considers that the resistance per ton of an empty car is two pounds greater than a loaded car. If we take an increase of 30 per cent for loaded cars on the level, we have 1.8 pounds at a speed of fifteen miles per hour, where the train resistance is six pounds, and this 1.8 pounds should be added to the regular resistance per ton. On grades, the effect will diminish in accordance with the formula:

$$e = \frac{1.8}{y_2 + 6} \qquad (5)$$

Where $e$ = the proportional increase in resistance of empty cars for the grade given, and $y_2$ = resistance due to grade in pounds per ton, we can therefore construct the following table:

VALUES OF $e$ FOR VARIOUS GRADES.

| FEET PER MILE GRADE. | RESISTANCE PER TON $= y_2$ | EXCESS IN PER CENT $= e$ |
|---|---|---|
| 0 | 0 | 30 |
| 10 | 4 | 18 |
| 20 | 7½ | 13½ |
| 30 | 11½ | 10½ |
| 40 | 15 | 8½ |
| 50 | 19 | 7 |
| 60 | 22½ | 6½ |
| 70 | 26½ | 5½ |
| 80 | 30 | 5 |
| 90 | 34 | 4½ |
| 100 | 37½ | 4 |
| 120 | 45 | 3½ |
| 140 | 52½ | 3 |

The weights of the empties are merely to be increased by these amounts when making up the allowance for the engine. While this does not allow for partially loaded cars, it has the advantage that it is simple and can be easily applied. On momentum grades, the virtual grade should be used in selecting the value of $e$.

## EFFECT OF WEATHER AND SEASONS.

There seems to be considerable difference in the opinions regarding the allowance that should be made for condition of weather, etc. A few roads make no allowance, particularly in Mexico. Others leave the allowance to the discretion of the operating officials. Several roads allow 4 to 6 per cent at night; many allow from 10 to 15 per cent in winter and from 5 to 10 per cent for wet rails. The Canadian Pacific and the Great Northern allow as follows:

7 per cent deduction for frosty or wet rail.
15 per cent deduction for freezing to zero temperature.
20 per cent deduction for from zero to —20 degrees.

The Columbus, Hocking Valley & Toledo Railroad seems, from Mr. Pomeroy's paper, to have gone more thoroughly and elaborately into this matter than other roads. For weather, or rather temperature conditions, they allow as follows:

TEMPERATURE RATINGS ON C. H. V. & T. R. R.

| Temperature. | Rating. | Value. | Value of No. 1. | Deductions. |
|---|---|---|---|---|
| 40 deg. and above Fahr. | 1 | 100 per cent | 100 per cent | 0 |
| 40 deg. to 30 deg.+ " | 2 | 94 per cent of 1 | 94 per cent of 1 | 6 per cent from 1 |
| 30 deg. to 20 deg.+ " | 3 | 94 per cent of 2 | 88 per cent of 1 | 12 per cent from 1 |
| 20 deg. to 10 deg.+ " | 4 | 93 per cent of 3 | 82 per cent of 1 | 18 per cent from 1 |
| 10 deg. to 0 deg. " | 5 | 93 per cent of 4 | 76 per cent of 1 | 24 per cent from 1 |
| 0 deg. to 10 deg.— " | 6 | 85 per cent of 5 | 65 per cent of 1 | 35 per cent from 1 |
| 10 deg. to 20 deg.— " | 7 | 91 per cent of 6 | 59 per cent of 1 | 41 per cent from 1 |

(The table is presented in slightly different form than previously published.)

In addition to the above, they make an allowance for the condition of the engine.

For engines out of shop 9 months and less, use table above.
For engines out of shop 9 to 12 months, deduct 6 per cent.
For engines out of shop 12 to 15 months, deduct 12 per cent.
For engines out of shop over 15 months, deduct 18 per cent.

It seems to your committee that these allowances are unnecessarily heavy.

After having shown how the proper load for an engine can be determined, let us see which is the best manner of making up that load. In replying to our circular, twenty-two roads advised that loading was figured by the actual scale weights, and eighteen by the stenciled light weight and the way-bill statement for loads. When practicable, your committee recommends the first method, as it is much more accurate.

Some roads have issued special instructions governing this point, and we will now present copies of same.

CHICAGO & WEST MICHIGAN RAILWAY.

"In determining the weights of empty cars the following estimated weights will be used:

| | |
|---|---|
| Furniture and box cars 40 feet and upward in length, and refrigerator cars.. | 20 tons |
| Box, stock and furniture cars 36 to 40 feet in length.................... | 18 tons |
| Box and stock cars under 36 feet in length............................ | 16 tons |
| Gondolas and oil tanks............................................ | 14 tons |
| Flat cars......... ............................................ | 12 tons |
| Extra way cars.................................................... | 15 tons |
| D. H. coaches .............. ................................. | 28 tons |

"When coaches, combination or baggage cars are used instead of way cars, ten tons will be allowed for additional weight.

"The weight of cars loaded with merchandise or other freight less than ten tons in weight will be computed by adding five tons to the estimated weight of empty car; provided the estimated weight of car and load must not exceed twenty-five tons.

"The weight of full loaded cars will be ascertained by adding the actual weight of load to the stenciled weight of car.

"To better enable yardmen and trainmen to ascertain the weight of loaded cars, agents will be governed by the following instructions, which must be complied with in all cases:

"In billing carload shipments they will show in heading of way-bill, directly over the words 'car initials,' the total weight of car and load, as follows:

"TONNAGE: The weight will be shown in tons, and in determining the same, should there be a fraction of less than one-half ton, it will not be taken into account, but should there be a half a ton or more it will be computed as one ton.

"Agents and conductors must show on switching list the tonnage weights of all cars shown upon the list.

"Agents at stations where cars are billed before being weighed will estimate the weight of load, in accordance with instructions given in G. F. O. Book of Rules; this weight to be corrected at weighing stations, if found to vary more than one-half ton from weight shown.

"Way-bills for each car loaded with merchandise, pedlars, etc , will be placed in an envelope, upon the outside of which the total weight of load and car will be shown.

"Conductors of trains picking up cars at stations where there are no agents will ascertain the weights in the manner shown above and will note the same upon the way-bills upon which the car is handled.

"Conductors will enter the total weights of car and load in their train books.

"In order that trains may be made up to the capacity of engine, extreme care must be exercised by all concerned in ascertaining weights and entering same on way-bills."

## ERIE RAILROAD.

"On and after August 1, 1896, in computing weights of trains for the purpose of rating engines, the unit of weight will be ONE THOUSAND POUNDS, instead of the net ton. For convenience, the character 'M' will be used to indicate ONE THOUSAND POUNDS.

"In computing weight of car and contents, less than five hundred pounds shall not be counted; more than five hundred pounds shall be counted one 'M.'

"For example, if a car contains a lading of 43,600 pounds, and the car weighs 22,100 pounds, making a total of 65,700 pounds, it shall be considered as 66 M, and the words '66 M' placed on the upper right-hand corner of the regular way-bill, card way-bill, way-bill envelope or manifest accompanying the car.

"When more than one way-bill accompanies a car they must be inclosed in way-bill envelope.

"CARS NOT STENCILED WILL BE ESTIMATED AS FOLLOWS:

| | | |
|---|---|---|
| Oil tanks | not stenciled | 25 M |
| Armour refrigerator cars | " " | 45 M |
| All other " " | " " | 40 M |
| Double-deck stock cars | " " | 33 M |
| Single-deck " " | " " | 27 M |
| Box and coal cars | " " | 26 M |
| Flat cars | " " | 20 M |
| Coaches, baggage and express cars | " " | 50 M |
| Parlor and sleeping cars | " " | 85 M |
| Dead engines | " " | 150 M |

"THE FOLLOWING ESTIMATED WEIGHTS OF LADING SHALL BE USED WHERE THE ACTUAL WEIGHTS CANNOT BE ASCERTAINED:

| | |
|---|---|
| Lading in refrigerator cars | 26 M |
| " " way freight " | 10 M |
| Hogs in double-deck " | 23 M |
| " " single-deck " | 14 M |
| Sheep and calves in double-deck cars | 17 M |
| " " " " single-deck " | 9 M |
| Horses and cattle | 21 M |

"On all other freight, when the actual weight of lading cannot be obtained, it must be carefully estimated, and when such cars are weighed at any point, proper correction must be made.

"The above is intended only for the purpose of rating engines on the 'M' basis, and must not in any way interfere with instructions issued by the Traffic Department."

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RAILWAY.

"The following schedule of tare weights may be used when moving empty cars, or when the weight of cars is not shown on way-bill:

| | |
|---|---|
| Box and charcoal cars | 26,000 |
| Furniture cars | 27,000 |
| Refrigerators | 35,000 |
| Stock cars | 25,000 |
| Ore cars and ballast cars | 24,000 |
| Cinder cars — empty | 25,000 |
| Cinder cars — loaded | 74,000 |
| Flat cars | 19,000 |
| Gondola coal cars | 20,000 |
| Oil tanks — empty | 28,000 |
| Cabooses | 28,000 |
| Pile driver | 84,000 |
| Steam shovel | 109,000 |
| Sleeping, dining and official | 85,000 |
| Coaches, 8 wheels | 65,000 |
| Baggage and mail | 60,000 |

---

"The following table of estimated net weights will be used when gross weight is not shown on way-bill:

| | |
|---|---|
| Green lumber, wheat and ties | Marked capacity of car. |
| Dry lumber, cord wood and slabs | 32,000 pounds. |
| Local way cars | 6,000 " |
| Merchandise | 30,000 " |
| Bark | 24,000 " |

SOUTHERN PACIFIC RAILWAY.

TRAIN LIST.

........................Division.

Train No................

Leaving............................

at........m. ..................189

| INITIAL. | CAR NO. | DESTINATION. | GROSS WEIGHT CAR AND CONTENTS. Ms. |
|---|---|---|---|
| 1 | 2 | 4 | 6 |
| ......... | ......... | ......... | ......... |
| ......... | ......... | ......... | ......... |
| ......... | ......... | ......... | ......... |
| ......... | ......... | ......... | ......... |
| ......... | ......... | ......... | ......... |
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| ......... | ......... | ......... | ......... |
| ......... | ......... | ......... | ......... |
| ......... | ......... | ......... | ......... |

1. Agents must fill out this blank and hand it to conductors for all cars leaving their stations.

2. Lading in way freight cars will be assumed as 10,000 pounds, or 10 Ms.

3. Weights must be taken from way-bills and from tare stenciled on equipment whenever possible. Otherwise use estimated weights, as provided below:

Tare for unstenciled cars:

| | |
|---|---|
| Oil tanks | 25 M. |
| Refrigerator | 40 M. |
| Cabooses | 30 M. |
| Flat | 20 M. |
| Coal cars | 22 M. |
| Box | 26 M. |
| Furniture | 28 M. |
| Common stock | 25 M. |
| Stable and double-deck stock | 32 M. |
| Arms palace horse cars | 40 M. |
| Coaches, tourist, baggage, mail and express | 50 M. |
| Pullman sleeping cars | 90 M. |
| Dead engines, 8-wheel | 150 M. |
| " " 10-wheel | 200 M. |
| " " 12-wheel and consol. | 225 M. |
| Lading in refrigerator cars | 25 M. |
| Lading in way freight cars | 10 M. |
| Hogs in double-deck cars | 25 M. |
| Hogs in single-deck cars | 15 M. |
| Sheep in double-deck cars | 20 M. |
| Sheep in single-deck cars | 10 M. |
| Horses and cattle, carloads | 20 M. |

On other freight, if actual weight cannot be obtained, it must be carefully estimated.

4. Show all weights in Ms (one M meaning 1,000); less than 500 pounds to be dropped 500 to 1,000 pounds to be counted as one M.

CHICAGO GREAT WESTERN RAILWAY.

"To enable yardmasters at the terminal and division yards to build up trains upon a tonnage rating without stopping to weigh every car, it is necessary that the tonnage of lading and tare weight of car be shown on the running slip or car cards. This must be done not only for local cars, but also for through cars which pass over several roads on one through bill or running slip.

"The weight of each carload, both car and contents, is first inserted in the way-bill by the agent. Fractions are not used, less than 1,000 pounds being dropped and over 1,000 counted as one ton. This information is shown on the switch list used by the yardmen in making up the train, empties being given an arbitrary weight according to the class of car. The weight of the cars and contents in the train, having been inserted in the conductor's report, is certified to by the agent and this information is sent at once to the dispatcher."

## WEIGHTS OF LADING AND TARE WEIGHTS OF CARS IN USE BY THE CHICAGO GREAT WESTERN RAILWAY.

### TABLE SHOWING WEIGHT OF CONTENTS OF CARS.

| Average Height of Load. | | WHEAT. | | | | | SHELL CORN, RYE AND FLAX. | | | | | EAR CORN. | | | | | OATS. | | | | | BARLEY. | | | | | TIMOTHY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Length of Car. | | | | | Length of Car. | | | | | Length of Car. | | | | | Length of Car. | | | | | Length of Car. | | | | | Length of Car. | | | | |
| | | 28 | 30 | 33 | 34 | 36 | 28 | 30 | 33 | 34 | 36 | 28 | 30 | 33 | 34 | 36 | 28 | 30 | 33 | 34 | 36 | 28 | 30 | 33 | 34 | 36 | 28 | 30 | 33 | 34 | 36 |
| Ft | In. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| 2 | 0 | 11 | 12 | 13 | 13 | 14 | 10 | 11 | 12 | 12 | 13 | 6 | 7 | 7 | 8 | 8 | 6 | 6 | 7 | 7 | 7 | 9 | 9 | 10 | 10 | 11 | 8 | 9 | 10 | 10 | 10 |
| 2 | 2 | 12 | 12 | 14 | 14 | 15 | 11 | 12 | 13 | 13 | 14 | 7 | 7 | 8 | 8 | 9 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 9 | 9 | 10 | 11 | 11 |
| 2 | 4 | 13 | 13 | 15 | 15 | 16 | 12 | 13 | 14 | 14 | 15 | 7 | 8 | 9 | 9 | 9 | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 12 | 13 | 9 | 10 | 11 | 11 | 12 |
| 2 | 6 | 13 | 14 | 16 | 16 | 17 | 13 | 13 | 15 | 15 | 16 | 8 | 8 | 9 | 10 | 10 | 7 | 8 | 8 | 9 | 9 | 11 | 12 | 13 | 13 | 14 | 10 | 11 | 12 | 12 | 13 |
| 2 | 8 | 14 | 15 | 17 | 17 | 18 | 13 | 14 | 16 | 16 | 17 | 8 | 9 | 10 | 10 | 11 | 8 | 8 | 9 | 9 | 10 | 11 | 12 | 14 | 14 | 15 | 11 | 12 | 13 | 13 | 14 |
| 2 | 10 | 15 | 16 | 18 | 18 | 20 | 14 | 15 | 17 | 17 | 18 | 9 | 10 | 10 | 11 | 11 | 8 | 9 | 10 | 10 | 10 | 12 | 13 | 14 | 15 | 16 | 11 | 12 | 13 | 14 | 15 |
| 3 | 0 | 16 | 17 | 19 | 20 | 21 | 15 | 16 | 18 | 18 | 19 | 9 | 10 | 11 | 11 | 12 | 9 | 9 | 10 | 10 | 11 | 13 | 14 | 15 | 16 | 17 | 12 | 13 | 14 | 15 | 16 |
| 3 | 2 | 17 | 18 | 20 | 21 | 22 | 16 | 17 | 19 | 19 | 20 | 10 | 11 | 12 | 12 | 13 | 9 | 10 | 11 | 11 | 12 | 14 | 15 | 16 | 17 | 17 | 13 | 14 | 15 | 16 | 16 |
| 3 | 4 | 18 | 19 | 21 | 22 | 23 | 17 | 18 | 20 | 20 | 21 | 10 | 11 | 12 | 13 | 13 | 10 | 10 | 11 | 12 | 12 | 14 | 15 | 17 | 17 | 18 | 13 | 14 | 16 | 16 | 17 |
| 3 | 6 | 19 | 20 | 22 | 23 | 24 | 18 | 19 | 21 | 21 | 23 | 11 | 12 | 13 | 13 | 14 | 10 | 11 | 12 | 12 | 13 | 15 | 16 | 18 | 18 | 19 | 14 | 15 | 17 | 17 | 18 |
| 3 | 8 | 20 | 21 | 23 | 24 | 25 | 18 | 20 | 22 | 22 | 24 | 11 | 12 | 14 | 14 | 15 | 11 | 11 | 12 | 13 | 14 | 16 | 17 | 19 | 19 | 20 | 15 | 16 | 17 | 18 | 19 |
| 3 | 10 | 21 | 22 | 24 | 25 | 26 | 19 | 21 | 23 | 23 | 25 | 12 | 13 | 14 | 15 | 15 | 11 | 12 | 13 | 13 | 14 | 16 | 18 | 19 | 20 | 21 | 16 | 17 | 18 | 19 | 20 |
| 4 | 0 | 22 | 23 | 25 | 26 | 27 | 20 | 22 | 24 | 24 | 26 | 13 | 13 | 15 | 15 | 16 | 11 | 12 | 14 | 14 | 15 | 17 | 18 | 20 | 21 | 22 | 16 | 17 | 19 | 20 | 21 |
| 4 | 2 | 22 | 24 | 26 | 27 | 29 | 21 | 22 | 25 | 25 | 27 | 13 | 14 | 15 | 16 | 17 | 12 | 13 | 14 | 15 | 15 | 18 | 19 | 21 | 22 | 23 | 17 | 18 | 20 | 20 | 22 |
| 4 | 4 | 23 | 25 | 27 | 28 | 30 | 22 | 23 | 26 | 26 | 28 | 14 | 15 | 16 | 16 | 17 | 12 | 13 | 15 | 15 | 16 | 19 | 20 | 22 | 23 | 24 | 17 | 19 | 21 | 21 | 22 |
| 4 | 6 | 24 | 26 | 29 | 29 | 31 | 23 | 24 | 27 | 27 | 29 | 14 | 15 | 17 | 17 | 18 | 13 | 14 | 15 | 16 | 17 | 19 | 21 | 23 | 24 | 25 | 18 | 19 | 21 | 22 | 23 |
| 4 | 8 | 25 | 27 | 30 | 30 | 32 | 23 | 25 | 28 | 28 | 30 | 15 | 16 | 17 | 18 | 19 | 13 | 14 | 16 | 16 | 17 | 20 | 21 | 24 | 25 | 26 | 19 | 20 | 22 | 23 | 24 |
| 4 | 10 | 26 | 28 | 31 | 32 | 33 | 24 | 26 | 29 | 29 | 31 | 15 | 16 | 18 | 18 | 19 | 14 | 15 | 16 | 17 | 18 | 21 | 22 | 24 | 25 | 27 | 20 | 21 | 23 | 24 | 25 |
| 5 | 0 | 27 | 29 | 32 | 33 | 35 | 25 | 27 | 30 | 30 | 32 | 16 | 17 | 18 | 19 | 20 | 14 | 16 | 17 | 17 | 18 | 22 | 23 | 25 | 26 | 28 | 20 | 22 | 24 | 25 | 26 |
| 5 | 2 | 28 | 30 | 33 | 34 | 36 | 26 | 28 | 31 | 31 | 33 | 16 | 17 | 19 | 20 | 21 | 15 | 16 | 17 | 18 | 19 | 22 | 24 | 26 | 27 | 29 | 21 | 22 | 25 | 25 | 27 |
| 5 | 4 | 29 | 31 | 34 | 35 | 37 | 27 | 29 | 32 | 32 | 34 | 17 | 18 | 20 | 20 | 22 | 15 | 16 | 18 | 19 | 20 | 23 | 25 | 27 | 28 | 29 | 22 | 23 | 25 | 26 | 28 |
| 5 | 6 | 30 | 32 | 35 | 36 | 38 | 28 | 30 | 33 | 33 | 35 | 17 | 19 | 20 | 21 | 22 | 16 | 17 | 19 | 19 | 20 | 24 | 25 | 28 | 29 | 30 | 22 | 24 | 26 | 27 | 28 |
| 5 | 8 | 30 | 33 | 36 | 37 | 39 | 28 | 30 | 34 | 35 | 37 | 18 | 19 | 21 | 22 | 23 | 16 | 17 | 19 | 20 | 21 | 24 | 26 | 29 | 30 | 31 | 23 | 24 | 27 | 28 | 29 |
| 5 | 10 | 31 | 34 | 37 | 38 | 40 | 29 | 31 | 34 | 36 | 38 | 18 | 20 | 22 | 22 | 24 | 17 | 18 | 20 | 20 | 22 | 25 | 27 | 30 | 31 | 32 | 24 | 25 | 28 | 29 | 30 |
| 6 | 0 | 32 | 35 | 38 | 39 | 41 | 30 | 32 | 35 | 37 | 39 | 19 | 20 | 22 | 23 | 24 | 17 | 18 | 20 | 21 | 22 | 26 | 28 | 30 | 31 | 33 | 24 | 26 | 29 | 29 | 31 |

The following Schedule of Tare Weights will govern:

| | | | | | |
|---|---|---|---|---|---|
| 33-foot box cars | 22,500 | Flats, coal | 18,200 | Coaches, 12-wheel | 67,500 |
| 34-foot box cars | 24,000 | Common stock | 24,000 | Coaches, 8-wheel | 63,000 |
| 36-foot box cars | 30,000 | Common stock (dirty) | 28,000 | Empty oil tanks | 28,000 |
| Furniture cars | 27,000 | Common stock, double-deck (dirty) | 30,000 | Derrick cars, complete | 50,000 |
| Refrigerators | 30,000 | Palace stock | 32,000 | Mogul engines and tanks | 156,000 |
| Foreign refrigerators | 38,000 | Palace stock (dirty) | 38,000 | Standard engines and tanks | 140,000 |
| Flats | 17,500 | Sleepers | 80,000 | Engine tank | 50,000 |

It occurs to your committee that the assignment of loads to engines by yardmasters, dispatchers and others would be greatly facilitated if each engine bore its class mark or letter on some conspicuous part, as, for instance, on the apron of cylinder immediately below the steam chest. This plan has been followed by the Norfolk & Western Railway.

In closing this report, your committee thinks that a few illustrations of the several existing methods of tabulating the tonnage rating for locomotives would be interesting and useful to those who contemplate inaugurating this system. Samples of the published rates are, therefore, given of the Great Northern, Southern Pacific, Wisconsin Central, Atchison, Topeka & Santa Fe and Norfolk & Western Railways. A proposed form is also exhibited, which, it is thought, has several valuable features, and which is recommended to the consideration of those interested in the subject. This is shown in Diagram No. 6.

G. R. HENDERSON,
F. HUFSMITH,
T. B. PURVES, JR.,
*Committee.*

ROANOKE, VA., March 4, 1898.

## GREAT NORTHERN RAILWAY LINE.

### CAPACITY OF DIFFERENT CLASSES OF ENGINES, IN TONS, IN ADDITION TO WEIGHT OF ENGINE, TENDER AND CABOOSE.

May 1, 1895.

BRECKENRIDGE AND WILLMAR DIVISIONS.

| STATIONS. | Ruling Grade. | 20 x 26 180 lb. | 19 x 26 180 lb. | 19 x 24 180 lb. | 19 x 24 150 lb. | 18 x 24 145 lb. | 17 x 24 145 lb. |
|---|---|---|---|---|---|---|---|
| **Minneapolis to Morris** | .6 | 1,625 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Willmar to Minneapolis** | .6 | 1,625 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Morris to Breckenridge** | .4 | 2,000 | 1,830 | 1,700 | 1,430 | 1,100 | 1,000 |
| **Breckenridge to Morris** | .4 | 2.000 | 1,830 | 1,700 | 1,430 | 1,100 | 1,000 |
| **Morris to Hancock** | .6 | 1,625 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Hancock to Willmar** | .4 | 2,185 | 1,800 | 1,670 | 1.380 | 1,070 | 960 |
| **Minneapolis to Hutchinson** | 2.0 | 600 | 500 | 475 | 390 | 310 | 280 |
| **Hutchinson to Minneapolis** | 2.0 | 600 | 500 | 475 | 390 | 310 | 280 |
| **Willmar to Marshall** | .6 | 1,620 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Marshall to Holland** | .6 | 1,530 | 1.400 | 1,300 | 1,030 | 800 | 710 |
| **Holland to Yankton** | .6 | 1,620 | 1,460 | 1.350 | 1,130 | 860 | 780 |
| **Yankton to Garretson** | .6 | 1,620 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Garretson to Ruthton** | .6 | 1,530 | 1,400 | 1,300 | 1,030 | 800 | 710 |
| **Ruthton to Willmar** | .6 | 1.620 | 1,460 | 1.350 | 1,130 | 860 | 780 |
| **Benson to Albee** | .6 | 1,620 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Albee to South Shore** | .75 | 1,240 | 1,120 | 1,030 | 880 | 660 | 590 |
| **South Shore to Huron** | .6 | 1.620 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Huron to Willow Lake** | .6 | 1,500 | 1,400 | 1,300 | 1,030 | 800 | 710 |
| **Willow Lake to Benson** | .6 | 1,620 | 1,460 | 1,350 | 1,130 | 860 | 780 |
| **Morris to Browns Valley** | .62 | 1,550 | 1,370 | 1,250 | 1,050 | 810 | 730 |
| **Browns Valley to Morris** | .76 | 1,340 | 1,120 | 1,040 | 870 | 660 | 590 |
| **Breckenridge to Aberdeen** | .6 | 1,560 | 1,410 | 1,300 | 1,080 | 840 | 740 |
| **Aberdeen to Breckenridge** | .5 | 1,560 | 1,410 | 1,300 | 1,080 | 840 | 740 |
| **Rutland to Ellendale** | .6 | 1.560 | 1,410 | 1.300 | 1.080 | 840 | 740 |
| **Ellendale to Rutland** | .6 | 1,560 | 1,410 | 1,300 | 1,080 | 840 | 740 |

SOUTHERN PACIFIC COMPANY.

RATINGS OF LOCOMOTIVES, SHASTA DIVISION, IN M'S OF 1,000 LBS. BETWEEN TENDER AND CABOOSE.

This Schedule supersedes drawings M. L. 173-1 and M. L. 173-2, dated June 21, 1897.

OFFICE MECHANICAL ENGINEER, SEPTEMBER 24, 1897.

DUNSMUIR AND RED BLUFF.
DUNSMUIR AND ASHLAND.

| Class. | Engine Numbers. | Type. | Cylinders. | Red Bluff to Cottonwood. | Cottonwood to Red Bluff. | Cottonwood to Redding. | Redding to Cottonwood. | Redding to Gibson. | Gibson to Dunsmuir. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F. A. | 1900 to 1912 | Con. | 19 x 30 | 1350 | 1800 | 1700 | 2000 | 1350 | 1050 | | |
| D. F. | 1762 to 1783 | 10 | 18 x 30 | 1060 | 1500 | 1400 | 1750 | 1060 | 760 | | |
| D. M. | 1547, 1548, 1658 to 1663, 1665 to 1670, 1672 to 1677 | 10 | 18 x 24 | 800 | 1100 | 1000 | 1350 | 800 | 600 | | |
| D. O. | 1581 to 1583, 1601 to 1607, 1609 to 1657, 1673 to 1683, 1589, 1590, 1554, 1555, 1558, 1559, 1561, 1565, 1562, 1584, 1585, 1592 to 1597 | 10 | 18 x 24 | 900 | 1200 | 1100 | 1500 | 900 | 670 | | |
| D. W. | 1521 | 10 | 17 x 30 | 950 | 1260 | 1160 | 1560 | 950 | 720 | | |

| Class. | Engine Numbers. | Type. | Cylinders. | Ashland and Siskiyou. | Coles to Zuleka. | Hornbrook to Siskiyou. | Hornbrook to Snowdon. | Edgewood and Snowdon. | Edgewood to Black Butte. | Dunsmuir to Sisson. | Sisson to Black Butte. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F. A. | 1900 to 1912 | Con. | 19 x 30 | 440 | 850 | 440 | 850 | 1350 | 620 | 620 | 950 |
| D. F. | 1762 to 1783 | 10 | 18 x 30 | 310 | 670 | 310 | 670 | 1060 | 450 | 450 | 650 |
| D. M. | 1547, 1548, 1658 to 1663, 1665 to 1670, 1672 to 1677 | 10 | 18 x 24 | 170 | 480 | 170 | 480 | 800 | 280 | 280 | 500 |
| D. O. | 1581 to 1583, 1601 to 1607, 1609 to 1657, 1678 to 1683, 1589, 1590, 1554, 1555, 1558, 1559, 1561, 1565, 1562, 1584, 1585, 1592 to 1597 | 10 | 18 x 24 | 260 | 570 | 260 | 570 | 900 | 370 | 370 | 590 |
| D. W. | 1521 | 10 | 17 x 30 | 290 | 610 | 290 | 610 | 950 | 390 | 390 | 630 |

# WISCONSIN CENTRAL LINES.

TONNAGE RATINGS FOR FREIGHT ENGINES. EFFECTIVE SEPTEMBER 22, 1896. CHICAGO AND MILWAUKEE DIVISIONS.

| Size of Engine | First Class Rate. | | | | Second Class Rate. | | | | Third Class Rate. | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 17 x 24 | 18 x 24 | 19 x 24 | 19 x 26 | 17 x 24 | 18 x 24 | 19 x 24 | 19 x 26 | 17 x 24 | 18 x 24 | 19 x 24 | 19 x 26 | |
| Chicago to Waukesha, through | 734 | 983 | 1101 | 1101 | 661 | 885 | 991 | 991 | 587 | 790 | 880 | 880 | |
| Chicago to Leithton | 1031 | 1381 | 1546 | 1546 | 928 | 1243 | 1391 | 1391 | 825 | 1105 | 1237 | 1237 | |
| Leithton to Grays Lake | 734 | 983 | 1101 | 1101 | 661 | 885 | 991 | 991 | 587 | 786 | 881 | 881 | |
| Grays Lake to Waukesha | 889 | 1190 | 1333 | 1333 | 800 | 1071 | 1200 | 1200 | 711 | 952 | 1067 | 1067 | |
| Waukesha to Chicago, through | 809 | 1084 | 1213 | 1213 | 728 | 976 | 1092 | 1092 | 647 | 867 | 970 | 970 | |
| Waukesha to Honey Creek | 809 | 1084 | 1213 | 1213 | 728 | 976 | 1092 | 1092 | 647 | 867 | 970 | 970 | |
| Honey Creek to Grays Lake | 980 | 1313 | 1470 | 1470 | 882 | 1182 | 1323 | 1323 | 784 | 1051 | 1176 | 1176 | |
| Grays Lake to Rockefeller | 910 | 1219 | 1365 | 1365 | 819 | 1097 | 1229 | 1229 | 728 | 975 | 1092 | 1092 | |
| Rockefeller to Chicago | 1031 | 1381 | 1546 | 1546 | 928 | 1243 | 1391 | 1391 | 825 | 1105 | 1237 | 1237 | |
| Waukesha to Stevens Point, through | 573 | 767 | 860 | 860 | 516 | 690 | 774 | 774 | 458 | 613 | 688 | 688 | |
| Waukesha to Byron | 613 | 821 | 920 | 920 | 552 | 739 | 828 | 828 | 490 | 656 | 736 | 736 | |
| Byron to South Oshkosh | 1120 | 1500 | 1680 | 1680 | 1008 | 1350 | 1512 | 1512 | 896 | 1200 | 1344 | 1344 | |
| South Oshkosh to Neenah | 741 | 992 | 1112 | 1112 | 667 | 893 | 1000 | 1000 | 593 | 794 | 889 | 889 | Helper at Oshkosh. |
| Neenah to Medina Junction | 573 | 767 | 860 | 860 | 516 | 690 | 774 | 774 | 458 | 613 | 688 | 688 | |
| Medina Junction to Stevens Point | 613 | 821 | 920 | 920 | 552 | 739 | 828 | 828 | 490 | 656 | 736 | 736 | |
| Stevens Point to Waukesha, through | 637 | 853 | 955 | 955 | 573 | 768 | 860 | 860 | 509 | 682 | 764 | 764 | |
| Stevens Point to Amherst Junction | 753 | 1009 | 1129 | 1129 | 678 | 909 | 1017 | 1017 | 602 | 807 | 903 | 903 | |
| Amherst Junction to Fremont | 1120 | 1500 | 1680 | 1680 | 1008 | 1350 | 1512 | 1512 | 896 | 1200 | 1344 | 1344 | |
| Fremont to Neenah | 637 | 853 | 955 | 955 | 573 | 768 | 860 | 860 | 509 | 682 | 764 | 764 | |
| Neenah to Fond du Lac | 1120 | 1500 | 1680 | 1680 | 1008 | 1350 | 1512 | 1512 | 896 | 1200 | 1344 | 1344 | Helper at Oshkosh. |
| Fond du Lac to Rugby Junction | 666 | 892 | 1000 | 1000 | 600 | 803 | 900 | 900 | 532 | 714 | 800 | 800 | Helper Fond du Lac to Byron. |
| Rugby Junction to Waukesha | 809 | 1084 | 1213 | 1213 | 728 | 976 | 1092 | 1092 | 647 | 867 | 970 | 970 | |
| Neenah to Manitowoc | 809 | 1084 | 1213 | 1213 | 728 | 976 | 1092 | 1092 | 647 | 867 | 970 | 970 | |
| Manitowoc to Neenah | 708 | 948 | 1062 | 1062 | 637 | 853 | 955 | 955 | 566 | 758 | 850 | 850 | Helper Manitowoc. |

## INSTRUCTIONS.

Following is average weight of empty cars. These weights may be used in computing tonnage in train only where weights are not shown on cars:

| | |
|---|---|
| 28 to 33 foot box cars ..........11 tons. | Common stock (double-deck, dirty) ...16 tons. |
| 34-foot box cars................12 tons. | Stable stock.... ..................14 tons. |
| 36-foot box cars................13 tons. | Stable stock (dirty).... ...........16 tons. |
| Furniture cars ..... ...........14 tons. | Ore cars... .......................12 tons. |
| Refrigerators (local).... ......15 tons. | Engine tank (empty)...............25 tons. |
| Refrigerators (dairy) ..........18 tons. | Empty oil tanks ....................14 tons. |
| Flats. ........................ 9 tons. | Combination box and tank . ......20 tons. |
| Flats (coal)....................13 tons. | Derrick cars (complete)...........25 tons. |
| Common stock.................12 tons. | Mogul engine and tank...........78 tons. |
| Common stock (dirty).........14 tons. | Standard engine and tank.........70 tons. |

When moving company material, such as bridge outfit, scrap, ties, etc., under special instructions without way-bills, conductors and agents will make careful estimate of the weight of contents.

First class rating will be used, except at such times as train dispatcher may direct that second or third class rating be used.

Locomotive rating is explained by 1-2-3 for the different classes of engines, and is defined as follows:

Rate No. 1.—Good rail and favorable weather.
Rate No. 2.—Inferior rail and unfavorable weather.
Rate No. 3.—Inferior rail and stormy weather.

The dispatcher will determine rate to be used, owing to the weather conditions.

Do not show fractions of tons, less than 1,000 pounds to be dropped, 1,000 pounds or over to be counted one ton.

Conductors on local freights may carry their way-cars at an average tonnage of five tons each, from the time such way-cars are picked up until set out or unloaded. Way-cars are defined as those from which freight is unloaded at local stations, or into which freight picked up at local stations is loaded.

The average gross tonnage of cars in dead freight trains is about 29 tons, in time freight trains about 20 tons, and in mixed freight trains about 25 tons. Carloads of potatoes will be estimated at 29 tons. Add one ton for stoves and linings in empty lined potato cars. If loaded in refrigerators, add nine tons. Carloads of ice will be estimated at 31 tons.

Where tonnage is estimated, so note on F. 1108.

Conductors are responsible for having their trains filled out to rated tonnage at starting point and during trip.

Time freight trains will use second class rate. Following trains will be considered time freight trains: 21, 23 and 25, also No. 24 when hauling live stock.

Conductors, yard clerks and yardmasters will show gross tonnage (as per way-bills) on their switch lists in TONS.

The above is maximum rating. Engineers unable to haul the prescribed rating will wire the train dispatcher the cause of failure, and will make a written report to the superintendent of motive power.

The above rating may be reduced five per cent when train consists of more than 35 cars, except between Ashland and Bessemer.

# THE ATCHISON, TOPEKA & SANTA FE RAILWAY CO.

## ENGINE RATING FOR NEW MEXICO DIVISION.—JULY, 1897.

LOADS: Actual Weight of Car and Contents.

Empties, plus 25 per cent.

TONNAGE CLASSES.

NOTE.—On level and descending grades an increased tonnage over that named shall be hauled between certain stations, as the Superintendent or his representative may direct. For fast freight a 10 per cent reduction may be made. During inclement or windy weather, a reduction from the established rating shall be made, at the discretion of the Superintendent or his representative.

No train of more than 50 cars.

| BETWEEN | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| La Junta and Trinidad | Loaded | 140 | 180 | 220 | 240 | 280 | 300 | 330 | 350 | 380 | 400 | 420 | 470 | 510 | 560 | 620 | 680 | 740 | |
| Trinidad and La Junta | rating, | 260 | 330 | 400 | 430 | 510 | 550 | 600 | 650 | 690 | 730 | 760 | 880 | 950 | 1030 | 1140 | 1240 | 1360 | |
| Trinidad and Raton, *a* | including | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | ...... | 140 | 150 | 160 | 180 | 200 | 220 | 240 | |
| Raton and Trinidad, *b* | Way Cars. | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 140 | 160 | 170 | 190 | 210 | 230 | 250 | |
| Raton and Las Vegas | .......... | 140 | 180 | 220 | 240 | 280 | 300 | 330 | 350 | 380 | 400 | 420 | 470 | 510 | 560 | 620 | 680 | 740 | |
| Las Vegas and Lamy | ............ | 110 | 130 | 160 | 170 | 200 | 220 | 240 | 260 | 270 | 290 | 300 | 350 | 370 | 410 | 450 | 490 | 540 | |
| Lamy and Albuquerque | ............ | 320 | 410 | 490 | 530 | 630 | 670 | 740 | 800 | 850 | 900 | 940 | 1080 | 1160 | 1260 | 1400 | 1500 | 1600 | |
| Albuquerque and Thornton............ | ............ | 300 | 380 | 460 | 500 | 590 | 620 | 690 | 740 | 790 | 830 | 870 | 1000 | 1080 | 1170 | 1300 | 1400 | 1500 | |
| Thornton and Las Vegas, *c* ............ | ............ | 120 | 140 | 180 | 190 | 230 | 240 | 270 | 290 | 310 | 320 | 340 | 390 | 440 | 460 | 510 | 550 | 590 | |

*a*—Helper, Trinidad to Lynn; *b*, Helper, Raton to Wootton; *c*, Helper, Lamy to Glorieta.

# TONNAGE RATING OF LOCOMOTIVES ON NORFOLK & WESTERN RAILWAY. ROANOKE, VA., MARCH 20, 1897.

## DESCRIPTION OF LOCOMOTIVES.

| Class | Type. | Diam. of Cylinders | Stroke. | Boiler Pressure. | Diameter of Drivers. | Total Wt. of Engine and Tender. Pounds. | Weight on Drivers. Pounds. | Adhesion to Track at 22%. Pounds. | Tractive Power at Given Speeds. Pounds. | Grate Area. Sq. Ft. | Heat'g Surface Sq. Ft. | Capacity and Style of Tender. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D.... | 10-Wheel ..... | 19 | 24 | 155 | 60 | 205,400 | 90,500 | 19,910 | 13,718 | 29.0 | 1,928 | 4,000 gal., Steel Frame |
| K.... | American..... | 18 | 24 | 140 | 62 | 147,800 | 54,600 | 12,012 | 9,557 | 16.8 | 1,139 | 3,000 gal. |
| N.... | American..... | 18 | 24 | 140 | 62 | 187,400 | 67,100 | 14,762 | 9,783 | 18.5 | 1,612 | 4,000 gal., Steel Frame |
| Q.... | American.... . | 17 | 24 | 140 | 62 | 143,900 | 52,200 | 11,484 | 7,271 | 16.2 | 1,029 | 3,000 gal. |
| U.... | 10-Wheel ..... | 14 24 | 24 | 180 | 68 | 220,170 | 102 300 | 22,506 | 15,020 | 29.0 | 1,967 | 4,000 gal., Steel Frame |
| C.... | 10-Wheel ..... | 19 | 24 | 140 | 55 | 156,600 | 70,500 | 15,510 | 15,510 | 16.5 | 1,379 | 3,000 gal. |
| E.... | 10-Wheel ..... | 18 | 24 | 140 | 51 | 138,000 | 52,000 | 11,440 | 11,440 | 15.8 | 1,144 | 3,000 gal. |
| F.... | Consolidation | 20 | 24 | 140 | 50 | 196,800 | 99,400 | 21,868 | 21,868 | 30.0 | 1,468 | 4,000 gal., Steel Frame |
| G.... | Consolidation | 20 | 24 | 150 | 50 | 210,600 | 110,300 | 24,266 | 23,780 | 31.0 | 1,774 | 4,000 gal., Steel Frame |
| H.... | 10-Wheel ..... | 19 | 34 | 140 | 55 | 161,560 | 78,700 | 17,314 | 17,314 | 16.5 | 1,375 | 3,000 gal. |
| I..... | Consolidation | 20 | 24 | 140 | 50 | 193,400 | 97,000 | 21,340 | 21,340 | 29.9 | 1,467 | 4,000 gal., Steel Frame |
| L.... | 10-Wheel ..... | 19 | 24 | 140 | 55 | 168,400 | 81,000 | 17,820 | 17,820 | 21.0 | 1,529 | 3,000 gal. |
| T.... | Consolidation | 14 24 | 24 | 180 | 56 | 225,000 | 125,300 | 27,566 | 27,566 | 31.0 | 1,888 | 4,000 gal., Steel Frame |

### ASSUMPTIONS MADE IN PREPARING THE TABLES.

Speed of passenger engines, 25 miles per hour on grade.
Speed of freight engines, 8 miles per hour on grade.
Maximum consumption of coal, 200 lbs. per square foot of grate surface per hour.
Adhesion to the track, 22% of the weight on the drivers.
Resistance for grade, .38 lbs. per ton for each foot rise per mile.
Resistance for speed of passenger trains at 25 miles per hour, 8 lbs. per ton.
Resistance for speed of freight trains at 8 miles per hour, 5 lbs. per ton.
Resistance for curvature, .7 lb. per ton per degree of curvature, for cars.
Resistance for curvature, 1.4 lbs. per ton per degree of curvature, for locomotives.
Resistance for curvature on reverse curves, 25% greater than simple curve.

### FACTORS LIMITING THE LOAD DRAWN BY ENGINES.

The adhesion to the track.
The power of the engine when working at the maximum cut-off at which the boiler can supply steam for the given speed and the maximum cut-off allowable by the valve gear.
The one giving the least power is taken.

### FACTORS LIMITING THE MAXIMUM CUT-OFF.

The amount of coal burned at 200 lbs. per square foot of grate surface per hour.
The amount of coal burned per square foot of heating surface per hour.
The evaporative efficiency of the boiler at the maximum rate of combustion.
The maximum amount of water evaporated per hour.
The cut-off pressure at the given speed. The mean effective pressure at the maximum allowable cut-off limits the engine power, where such power is less than the adhesion.

ents have gone into this several times, and the amount of difference on the average is hardly worth considering if the work is carefully done. The question that comes to my mind is, to what extent shall we employ the method of actually weighing the cars?

MR. HENDERSON: Several of the railroad companies reporting on this question seem to prefer the method of weighing, and if Mr. Marshall will refer to page 15, the Chicago & West Michigan, he will see that "The weight of full loaded cars will be ascertained by adding the actual weight of load to the stenciled weight of car." And again, on page 16, the Erie — "On all other freight, when the actual weight of lading cannot be obtained, it must be carefully estimated." So that it seems that a number, when they are able to do so, actually obtain the weight. Of course, in a large number of cases, as with coal or other bulky goods of that kind, it is weighed and the weight noted on the way-bill, and the weight given on the bills, and the weight of the car would, of course, give the total weight. Sometimes that cannot be done, because it may be that the scales are not convenient at the point the train is made up. One of our divisions has made the arrangement Mr. Marshall speaks of, and estimates the weights of cars, and loads the engine in proportion to that. But we were a little in doubt about the tonnage some of the engines were estimated to draw, and we found the actual weight exceeded the estimated weight. So where it is possible to use the actual weights, it is better to do that; but, of course, if it cannot be done, you have to use the best you can.

MR. MANCHESTER: Mr. Chairman, there are several points brought out in the paper which, while they are good, are often quite difficult to follow, and often do not give the actual results. For example, the point of condition of engines — our experience is that an engine is in good condition to handle a train up to the time that its tire gets so bad that it fails to maintain its traction, and I would not consider an engine unfit to hitch on to any train to take the maximum tonnage until it had reached that condition. In making up trains on a busy division, the yard room and the rapidity with which trains have to follow out after each other often determine whether the method of loading by tonnage can be used. Therefore, any method that will give the quickest results approximately will probably be used, and that can be facilitated by the use of engines of one class on a division. I believe that better results would always be obtained and the trains would be handled nearer to a full tonnage rating, if it

were made the practice of railroads to so assign their power that all engines running on a division in a similar class of service would be of one class, so that when the yardmaster is making up his train and getting it ready to go forward he would not have to be advised as to what class of engines was to take the train out. That is also advisable in arranging the power for divisions that run in connection with each other, that the engine delivering the train to an intermediate yard may be of a class to take up the same train and pull it forward. As to the theoretical rating of the engine, we found, in making a number of tests with a dynamometer car, that the profile failed to indicate certain draft strains that showed upon the dynamometer car, and upon inquiry discovered that the profile was as originally made, but that in ten or fifteen or twenty years the elevations or curvatures had all been changed, so that, in fact, the profile was a very poor guide to go by.

MR. FORSYTH: I am very glad that Mr. Henderson's paper has not been allowed to pass entirely without discussion, and I would like to take a short part in the discussion. I agree with Mr. Manchester in what he says about the profile; that it really introduces another variable in addition to the six items which Mr. Henderson has mentioned in his paper, and necessary for a theoretical determination of tonnage rating. There is another variable which is hard to measure and which is not taken account of, and that is the speed. In any theoretical determination for value of momentum or velocity head, the variable as to speed and the results determined depend upon the square of the speed. So that any slight variation in speed, or any error in the knowledge of the true speed, makes a great difference in the result obtained as to the value of the velocity head. This whole subject of tonnage rating is, I think, one of the most valuable things which Master Mechanics could interest themselves in in attempting to economize in the cost of transporting freight. Mr. Henderson has put the subject in such convenient and complete shape in this report that I think we ought to all feel indebted to him for the hard work he has done on it, and my one suggestion in the use of the report is that there should be a coöperation of the Master Mechanics with the superintendent and the chief engineer, and I believe that if such a committee on any railroad would take this report and try to improve the method of working a railroad on a tonnage basis, that it would produce astonishing results, and some which are, perhaps, now entirely unsuspected. I believe

that it would result in a great improvement of the alignment of the track and a great improvement in the superintendent's method of operating traffic.

MR. DAVID BROWN: Mr. President, this matter is quite new on our system. Mr. Henderson in his report stated that some had been using tonnage rating for fifteen years, others for three months. I guess we are among those running about three months. Previous to this we had been using the old plan of counting so many cars. We had been basing our operations on the jimmies — working jimmies so long — that we had to take so many jimmies. By and by the gondolas came in, and so many gondolas were considered equal to so many jimmies. Consequently some engines were overloaded and others went along with their trains in good shape. But we got in line along with the rest of the roads, and got on the tonnage system. I think this committee that has been appointed and has made the report was very much in order. We were all new at the business, and their remarks will come in and brace us up some. I will state that we have obtained a decided advantage by going into the tonnage rating. We get our weights from the mines; the way-bills also give the weights and the weights are tacked on the cars so that there is no trouble in getting the weights, so that now each engine has a fair share of the work to do, and we are taking a great deal more coal over the road, and our road is very undulating. We have got to take so many for a certain distance, and so many more at another point, and so on. There is one great advantage we gain: Formerly we used to leave cars at a certain point, but now we have abandoned that. By considering the tonnage and going into the profile of the road, we found it was not necessary to leave off those cars, and we take trains through with more tonnage than formerly, and it is a decided improvement. This committee's report will certainly be of very great benefit to those that are new at the business, and I find that the average is only two years; consequently there must be a great many of us to whom the committee's report will be a benefit.

MR. HUMPHREY: Mr. Chairman, having had eight years' experience in the rating of engines on a mountain road, I might say something that would be of interest. We not only have to rate engines on an up-grade through the Rocky Mountain regions, but we rate them on a down-grade as well; as it is not possible to handle with the air brakes as long a string of cars down a hill as we would often like to, we arrive at the basis of the train prac-

tically on the same basis, I might say, in descending grades as we do in ascending them. The suggestion has been made in regard to the theoretical rating and the profiles as furnished by the engineering department of a railway. Now, we have in one particular part of our road a grade ascending on one side of 2 per cent; ascending on the other side, the profile only shows 1.66 per cent. Our engines were theoretically rated in 1890 so as to haul what we supposed they would haul on a 1.66 per cent grade. We found that they could not nearly haul that rating. By practically testing the engines, we found that the same sized engine could haul the same rating up the 2 per cent grade as it could up the 1.66 per cent grade; so that the profile must have been out or there would not have been that equality in the loads we could haul. Some of the reports look a little bit unreasonable. I will draw your attention to the last item in the table on page 4, where they deduct 41 per cent for curvature and the different degrees of temperature. In operating over our mountain regions where we have 3 and 4 per cent grade, in one place forty miles of a continuous 3 per cent grade, and where a 21-inch engine will handle less than 300 tons — I think it is 294 tons — if we should deduct the 41 per cent grade for the conditions of the weather, and then as you go down, and deduct 18 per cent for the condition of the engine that has been out of the shop fifteen months, you can readily see that you would only have about 35 per cent left of the 300 tons, approximately, to haul up the forty miles of 3 per cent grade. So that a great deal of the time we would be operating trains over the road with less than 35 per cent; or in other words, a 21-inch engine would handle less than two cars over this portion of the road; so it can be seen, if this should be followed out in detail, operating through the mountains would be very expensive indeed. Now, we do not make any reduction whatever in engines. When an engine gets so that it cannot handle the full rating, the engine goes into the shop and is put into condition. We do deduct for cold weather; 10 per cent for stormy weather. We arrive at the rating basis by taking the actual weights of the cars as near as possible; that is, the way-bill rating. We have an arbitrary weight for each class of cars; we rate a box car, approximately, at 26,000 pounds, or 13 tons. A refrigerator car is rated at 21 tons, a coal car at 11 tons and a flat car at 9 tons. So we take the total number of cars in a train and the total amount of lading. Then by taking the lading we find how many cars that would make at the rate of 50 tons to the car. Then we figure that many loaded cars at

the rate of 50 tons to the car at 13 tons to the car. Then we find that the friction around curves, by practical demonstration, on an empty car is equal to 5 tons more than a loaded car; so that in all cars over and above the cars that we consider are actually loaded in the train we add 5 tons for friction. In this way we arrive at the actual tonnage in a train, and do not permit any train to go over the road that is not loaded as near the maximum rating of the engine, which is generally a three-engine train, as it is possible to get.

THE PRESIDENT: I think that, in all fairness to the committee, the footnote that they put on here to the effect that they consider this allowance excessive, should be taken into consideration. Is there any further discussion?

MR. HENDERSON: If there is no further discussion, I believe I am entitled to the closure. Mr. Manchester and Mr. Forsyth both spoke — possibly I misunderstood the intent of their remarks, but I gathered from what they said that the profile should be considered and that it had been omitted in the list given on page 5. Now if the members will look at the third item in the list on page 5 they will find it says "Resistance of Trains," and on page 7, speaking of resistance of trains in detail, it says there that the diagram given in this report will make all allowance for speed, grade, curvature and acceleration. So while we have not specified the words profile or different grade of curvature, yet under the head of resistance of trains it is all included, as will be seen by reference to the middle paragraph on page 7. Of course it would be a very important thing, and we could not begin to overlook the profile or curvature in the road. That is the most important feature. Mr. Humphrey speaks of the fact that the profiles are not correct. Of course, while we have to recognize that, your committee cannot be charged with the fact that some of the chief engineers give incorrect profiles. We presume that if persons work on profiles they have reason to believe that the profiles are correct. That ought not to be laid to the committee. The President has just referred to the fact that the committee says on page 14 that these allowances are unnecessarily heavy. We thought so ourselves, and that is why we tried to file a disclaimer on such extraordinary allowances. Mr. Humphrey also spoke of five tons allowance on all empties. It does not seem to me that that is exactly the way to handle it, because you would have to make a different allowance for each different grade. On page 13 it will be readily seen that the excess for empty cars must be reduced as the grade increases,

because, of course, the action of an empty is merely frictional resistance on the level, and when you come to resistance on a grade it cannot have any increase over its own empty weight. So that his allowance of five tons cannot be used as a rule suitable for all grades. But we think the table on page 13 is applicable to any grade. I think I have answered the different questions brought up, and I merely wanted to get that explanation in before the subject was closed.

MR. MACKENZIE: I move that the discussion be closed.

THE PRESIDENT: Gentlemen, in the vote to receive this report we of course will take it for granted that it is to be printed in the proceedings. That was not definitely stated.

MR. MACKENZIE: I think, Mr. Chairman, that the acceptance of a report, unless there is objection, implies that it should be entered in the proceedings.

THE PRESIDENT: We will accept that as the intention. It is moved and seconded that the discussion be closed.

The motion was carried.

THE PRESIDENT: Gentlemen, please listen to an announcement by the Secretary.

MR. CLOUD: It is suggested that Reports Nos. 2 and 3 be postponed for later consideration, because Report No. 2 was handed to me here at Saratoga and has been printed here, and therefore has not been distributed to the members. Similarly, a supplementary report on Subject 3 by Mr. Sague has been printed here at Saratoga, and these two reports, Report No. 2, and the supplementary report, No. 3, which you have not seen, will be placed at the door so that you may get copies of them, in passing out, to look over, and be prepared to discuss them at a future session.

THE PRESIDENT: Gentlemen, unless there is some objection to this, we will defer the reading and discussion of Reports Nos. 2 and 3 until either after the rest of the subjects have been discussed or until they are called up by some member of the Association. We will now pass to No. 4.

THE PRESIDENT: Gentlemen, on this subject of Report No. 4, on "Best Methods of Boiler and Cylinder Insulation," as Mr. Deems is not here, we have asked Mr. McIntosh to take the subject up.

**Mr. McIntosh read the following report:**

## REPORT OF COMMITTEE ON BEST METHODS OF BOILER AND CYLINDER INSULATION.

*To the President and Members of the Master Mechanics' Association:*

Your committee, appointed to report on the "Best Method of Boiler and Cylinder Insulation," issued a circular of inquiry to which there have been thirty-four replies, representing 11,329 locomotives.

The circular and replies were as follows:

1. Do you use any kind of insulating covering for your boilers, other than wood?

To this twenty-eight railroads, representing 10,098 locomotives, replied in the affirmative; five, representing 582 locomotives, replied that they used wood only; one railroad, representing 649 locomotives, stated they used wood covering principally, but were trying a few other kinds to find the relative value.

2. If so, what has been your experience, compared with wood lagging, from an economical standpoint?

To this five replied they had no experience, seven did not venture an opinion, account of limited experience, twenty-two replied it was more economical than wood.

3. If you have made any tests, please give committee the result, setting forth the manner of arriving at same.

To this all replied they had made no special tests.

4. Give cost per square foot applied, and kind of lagging referred to; the latter for information of your committee only.

There were twenty replies to this; nine showing lagging costs from 21 to 29 cents per square foot applied, eleven stating that it costs from 7 to 18.6 cents per square foot, according to thickness.

5. If any experience with lagging the sides and heads of boilers, please give same.

Two roads replied that they lagged both sides and heads of boilers; four that they lagged the sides only; three that they lagged the heads of certain engines, with large boiler heads, account of excessive heat in the cabs.

6. If any experience in improved methods of lagging steam chests and cylinders, please give, in detail, the manner of doing it.

To this, nineteen replied that they had no experience whatever in lagging cylinders and steam chests. Of the fifteen that had some experience, six used wood, one filled all spaces around casings and coverings with hair felt, eight used different kinds of insulation. Note cuts showing the methods of lagging locomotive cylinders and steam chests; also of attaching removable lagging on sides of locomotive boilers, so staybolts can be readily inspected and repaired.

In order that all members may be conversant with the manner in which the committee arrived at their conclusions, the method adopted was as follows:

Samples were furnished by the manufacturers, with the exception of the wood, and in addition to these samples the committee took from store stock additional sam-

ples of each kind, which were tested along with those furnished by the manufacturers. The reason for this is obvious.

No. 1. This sample contained:

| | | |
|---|---|---|
| Asbestos | 7.19 | per cent. |
| Lime (calcium oxide) | 31.64 | " |
| Sulphur tri-oxide | 48.70 | " |
| Loss by ignition | 9.60 | " |

No. 2. Pine wood.

Nos. 3, 4 and 5. These samples contained:

| | 3 and 5. | 4. | |
|---|---|---|---|
| Asbestos | 68.38; | 64.84 | per cent. |
| Oxide of magnesia | 16.75; | 22.70 | " |
| Loss by ignition | 14.90; | 13.00 | " |

No. 6. The bare pipe.

No. 7. This contained:

| | | |
|---|---|---|
| Asbestos | 43.97 | per cent. |
| Lime | 51.28 | " |
| Rope | 1.83 | " |
| Sawdust | 2.92 | " |

Nos. 8 and 9 contained as follows:

| | | |
|---|---|---|
| Asbestos | 4.0 | per cent. |
| Carbonate of magnesia | 95.3 | " |

No. 10 contained as follows:

| | | |
|---|---|---|
| Asbestos | 46.6 | per cent. |
| Alumina and iron oxides | 11.0 | " |
| Magnesia oxide | 25.5 | " |
| Loss on ignition | 14.3 | " |

Nos. 11 and 12.

No. 11 contains as follows:

| | | |
|---|---|---|
| Asbestos and silica | 31.60 | per cent. |
| Oxide iron | 2.00 | " |
| Oxide aluminum | 15.30 | " |
| Oxide calcium (lime) | 35.10 | " |
| Oxide magnesia | 3.59 | " |
| Sulphur tri-oxide | 7.58 | " |

Samples Nos. 5, 8 and 11, being received in sheet form, were fitted to the pipe; the others were received in cylindrical form to fit a 4-inch pipe.

The samples, which were each twelve inches in length, were placed on the pipe with a space of two inches separating them; the ends and joints on each sample were sealed up to avoid the possibility of air circulation in the interior of the samples.

On each sample was placed a reservoir made of tin, 5⅜ by 10 inches in size, with concave bottom to fit the sample, each having an exposed radiating surface of about 136½ square inches and containing 3½ pounds of water.

The thermometers used were carefully calibrated and compared.

A steam gauge which had been compared with a standard test gauge was placed on each end of the pipe.

The thermometers were inserted at the centers of the reservoirs to an equal depth into the water, after which the reservoirs were sealed tight.

The reservoir marked No. 6, which was placed on the bare pipe, exposed about 220.7 inches of radiating surface, and contained 7½ pounds of water. For this reason, and the fact that the water in this reservoir boiled so soon after steam was turned into the pipe, the time temperature curve is incorrect; this could, however, be omitted without detracting in any way from the value of the tests.

A steam connection was made at one end of the pipe, and a drain provided at the other, the latter being kept slightly open during the test.

Observations began at 7:15 P.M. and were taken every five minutes up to 9:40 P.M, and from that time up to the close of the test every ten minutes, the result of which is clearly shown in Figs. 1 and 2, the former showing clearly the rise in temperature of the water in the reservoirs; the latter the temperature readings every five and ten minutes, as stated.

Mr. T. Lyon, Master Mechanic of the Chicago Great Western Railway, in answer to the committee's inquiry, gives some interesting figures, based on the result of a test conducted by him some time ago, as follows:

"Prepared two lengths of 2-inch iron pipe, each six feet long and connected with a boiler, by covering one of them with wooden lagging and a russia iron jacket, and the other with mineral covering about one inch thick and a similar russia iron jacket. These pipes were placed on an angle so that the water of condensation would drain toward one end, where there was a small cock, and both ends, as well as the steam pipes leading to them, were well covered by being wrapped with hair felt.

"Steam was turned on and the water of condensation drawn from each pipe and weighed at intervals of one hour, the amount of water being considered as a measure of the relative efficiency of the covering as non-conductors of heat.

"With an average steam pressure of 76 pounds (absolute) in the steam pipe and an average temperature in the room of 56 degrees, the mean loss from the pipe lagged by wood was three pounds of steam per hour, and that from the pipe lagged with mineral, nine-tenths pound per hour, corresponding to a loss of heat of 448 B. T. U. and 139 B. T. U. per lineal foot per hour, respectively. This would indicate that the mineral lagging is almost three times as effective as the wooden lagging."

He goes on to state that the loss of heat would be about 0.34 B. T. U. per square foot on radiating surface per degree of difference in temperature of the steam and the outside air, using mineral lagging, and 1.10 B. T. U. using wooden lagging, showing a difference in favor of the former of 0.76 B. T. U., and gives the following example:

"Taking a boiler with 300 square feet of radiating surface, carrying 160 pounds of steam and a mean outside temperature of 50 degrees Fahr., the difference in the loss would amount to 830 pounds of water in ten hours, representing, say, 166 pounds of coal, or, at $1.50 a ton, 12½ cents' worth. This should represent approximately the saving in coal by the use of a lagging such as tested instead of a wooden lagging under average conditions, and if these figures are correct, the mineral lagging would about pay for itself in a year. These experiments were made in still

air; the conditions in service on a locomotive being still more favorable for further economy."

We found it impossible to collect any reliable data based on actual and practical results, as to fuel economy, as the variables entering into a test of this nature are so great; hence it was not considered advisable to undertake it.

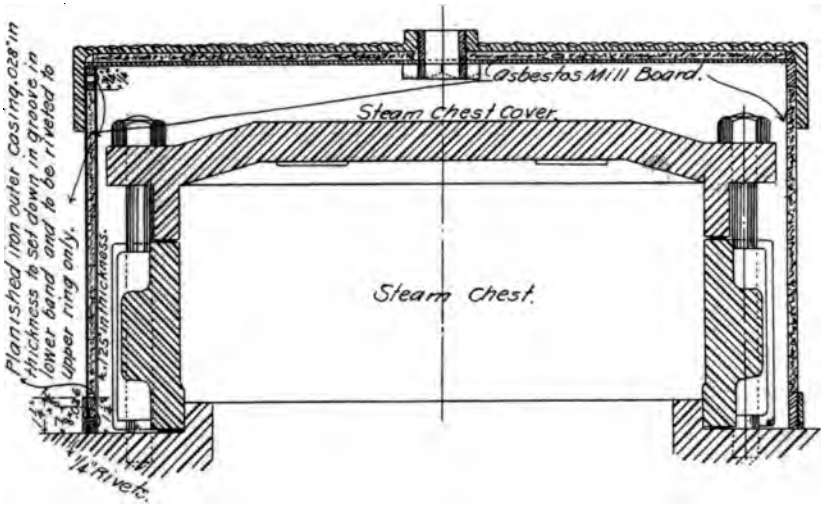
Your committee is decidedly of the opinion, notwithstanding the absence of this latter information, that economical results will follow the use of good non-conducting material, carefully applied to the boilers, cylinders, steam chests, steam passages, and all radiating surfaces where conditions are such that the estimated economy will not be overcome by the inconvenience and expense of removing same for repairs.

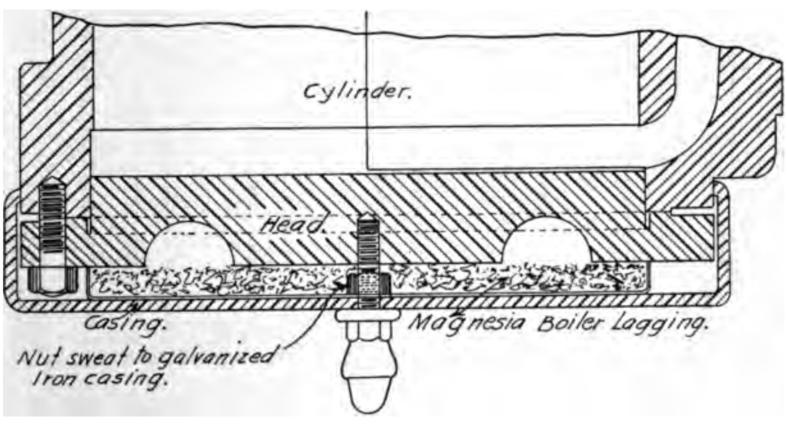
J. H. MANNING,
J. F. DEEMS,
WM. MCINTOSH,
*Committee.*

OMAHA, NEB., April 29, 1898.

## UNION PACIFIC.

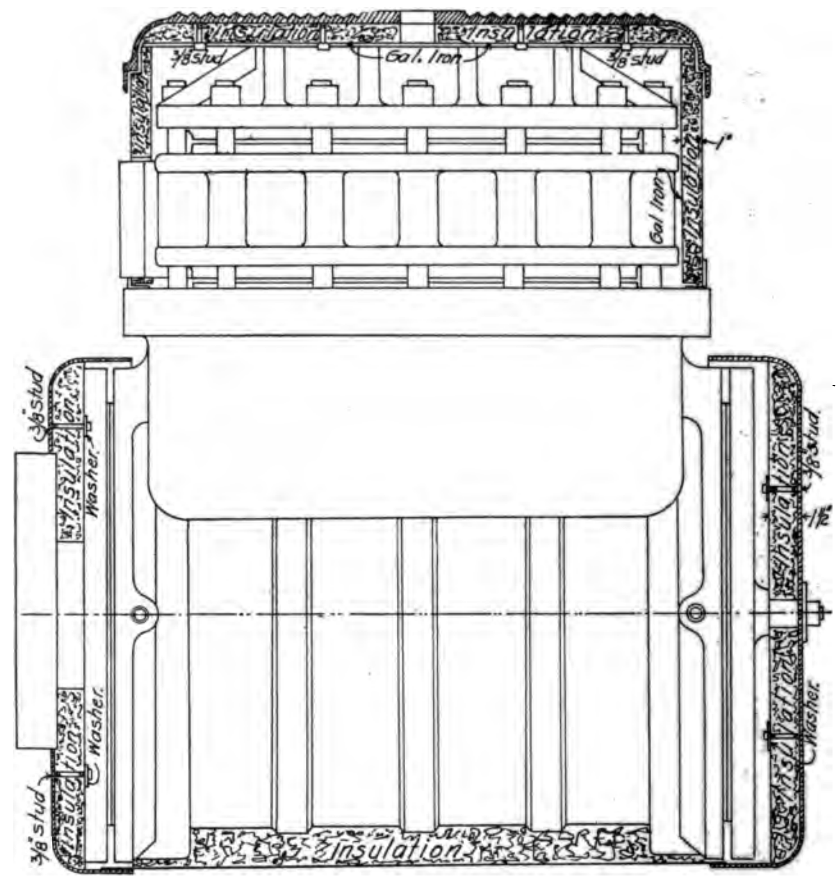
### Method of Lagging steam chests & cylinder heads.



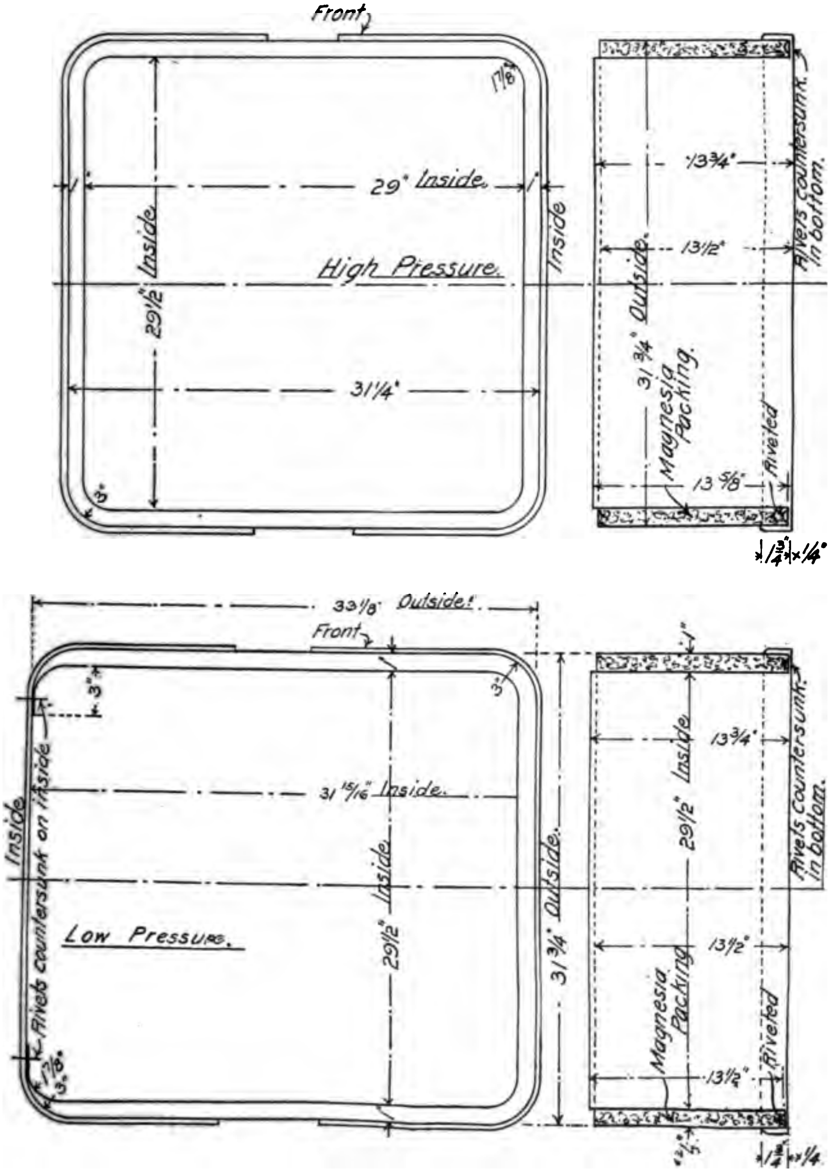



## C. & N. W. RY.

## INSULATION FOR LOCOMOTIVE CYLINDERS.



# NORTHERN PACIFIC R.R.
## STEAM CHEST CASING FOR CLASS "R" ENGINES.



The President: Gentlemen, you have heard the report of the committee. What is your pleasure to do with it?

Mr. Waitt: I move that the report be received and opened for discussion.

The motion was carried.

Mr. Wagner: Inasmuch as the committee gave the result of tests by Mr. Lyon, of the Chicago & Great Western, and as similar experiments are recorded in the transactions of the American Society of Mechanical Engineers, which tests were made by the Solway Process Company, at Syracuse, on sixty feet of 8-inch pipe, I would like to call the attention of some of the members who have not those transactions to such tests. There are also extended tests made by the Boston Manufacturers' Mutual Fire Insurance Company, entitled "Steam Pipe Covering, Boiler and Cylinder Laggings," being their Circular No. 65. That is under date of 1896. There is another one, "Tests of Steam Pipes and Boiler Coverings," by C. L. Norton, Massachusetts Institute of Technology, under date of 1898. And in order that all the members might have the benefit of these tests I would suggest that the committee be continued, especially as the work is new yet and as much new data is being developed. In relation to pipe, the manner of covering the lagging is somewhat important. The outside covering with canvas where exposed to gases is liable to decay, and a little more expensive method is to cover with thin sheet iron, in sections 24 to 26 inches long and rolled to the proper diameter, closed by two little buckles. It is very easily made and is lasting, and where the covering is subjected to acid water or fumes when painted it gives a very good surface.

Professor Hibbard: I notice that the report refers to a boiler and cylinder covering, but neglects the portion of the boiler where heat may be lost between those two, namely, in the saddle casting, and particularly is this important in the anthracite-burning locomotives with a very high saddle necessitated, with the wide boiler extending out over drivers. You find almost everywhere that the saddle casting is designed so that the steam passage is separated from the atmosphere by a most excellent heat-conducting material, namely, perhaps an inch or ⅞ of an inch of cast iron, with no insulating covering outside of that. Necessarily heat is lost there. One of the methods that is made use of to overcome that is found on the Lehigh Valley, where they have a recess on the side of the saddle casting

about an inch deep, and fill that with asbestos cement and cover it with a piece of sheet iron. The preferable method, as I think, is that which has been introduced on the Pennsylvania, in their Class L engines, in which the walls of the steam passage are separated from all other cast-iron walls by an air space in the neighborhood of two inches thick; that is, the steam pipe is free from touching other portions of the saddle casting from the end of the branch pipe in the smoke box until it comes just over the cylinder casting. That renders the pattern somewhat more complicated. Then that space between the steam pipe walls and either the exhaust passage walls or the exterior walls of the saddle casting is filled with loose asbestos or other material which will prevent circulation of air. Then the under side of the saddle casting is covered with wood to prevent circulation of air up from underneath the saddle casting.

MR. GAINES: We made some tests to find if it was going to pay us to discard wood lagging and go into the mineral sectional lagging, and I have figures of the results of those tests that may be of value and interest. The tests were conducted in much the same manner as the Solway tests mentioned before. We tested several mineral, one vegetable and the common wood lagging, and we finally figured it out. The loss per hour per square foot of surface per degree difference in temperature was found to be .36 B. T. U. for best mineral, .64 B. T. U. for worst mineral, 1.93 for wood. Figuring that way, on an average engine we find that the best covering saves, over wood, after deducting six per cent interest on first cost and application and ten per cent depreciation, $54.98 a year in fuel, and saves over the second best $14.96, and we are using a fuel that is cheap. Those that have more expensive fuel would find these figures run up much higher. The test has shown that there is not only a large saving in using the mineral covering, but it also pays well to use the best.

A MEMBER: I would like to ask the price paid for coal.

MR. GAINES: I would like to say that it varies on different parts of the line from 80 cents a ton to $1.50 a ton, the highest used in the freight engines. As a rule it is a mixture of buckwheat and soft coal.

MR. QUAYLE: I think the subject of covering for boilers and steam pipes on a locomotive is very important, and my attention is drawn to test No. 7, which is similar to the one we are using on the Chicago & North-Western Railway. By the way, I might preface my

remarks by saying that on the North-Western Railway for some years the pipes have been separated from the partition wall, and that years ago they used to fill in there with mineral wool by putting in a sheet-iron covering on the bottom to prevent it from coming out, and I believe that a great many roads in the country are practicing that today. But with regard to No. 7, I want to say that that is not just the formula used on the Chicago & North-Western road, although I believe it was intended for it, consequently the results obtained will be deficient in the degree, I think, that this varies from the regular formula. We use equal parts of asbestos, slack lime and sawdust, and the lime must of necessity be slacked seventy-two hours, we claim, before it is used. On high-pressure boilers we claim that sawdust becomes efficient after it is used, simply for the reason that the sawdust becomes charred, and as a result we have little air cells all through it, which, as you know, makes a very excellent conductor. In covering boilers my experience has taught me that we must have our boilers properly covered at the front end, and whatever covering we put on must properly adhere to the boilers, and for that reason I have not been an advocate of sectional covering, although I presume the majority of the men present will not agree with me. If we allow the front end of the boiler in any manner to admit air under the covering, the heat is carried off into the cab; but if you put on a plastic covering it adheres so closely to the boiler that the air cannot pass under it, nor does it pass through it and carry off the heat in that manner when the engine is in high winds and at high velocity. There is not any question in my mind that the superior non-conducting quality of material used on locomotive boilers will give you the maximum results in the laboratory, but if improperly put on your results will vary and the air will carry the heat off from the boiler when it ought to be retained. It is not so much difference, I think, what is lost by radiation as what is lost by being carried off by circulation at high speeds, and for that reason alone I am an advocate of a plastic covering, and if I were to refer to a magnesia covering I should advocate, by all means, the use of it in a plastic form rather than in the form of a sectional covering.

Mr. Gaines: I think the last speaker made the statement that with a sectional covering you could not get a close fit at the end of the engine. You can put a plastic covering around the front end between the end of the lagging and your joint ring and make a completely tight job. I have seen engines out for three years with this covering

on, and it was perfectly tight and no chance for air to get in any more than the day it went out.

MR. ATKINSON: Is there not a mistake in putting a plastic covering where it is actually in contact with the boiler plate? Where the sectional covering has a film of air between, if that air can be protected from circulation and cannot be blown out, it renders the covering better than if the plastic covering is in actual contact with the plate.

MR. T. R. BROWNE: I just want to say for general information that on the Pennsylvania we have been using sectional covering for several years, applying it to all new engines, and when that section covering is put on, it fits very tightly. On such portions of the boiler where it would not be practicable to make it fit satisfactorily we apply it in the form of mud or plaster, dropped over the hip corners and that portion of the smoke-box connections with the front barrel where there is a large ring, and it would be very thin if you attempted to put it on in sections. I feel morally certain that very little air gets past through the lagging of the boiler or between it and the sheets. It is put on connected with wires which hold each block in place, not only holding on one block, but the one next above it, and then drawn on tightly to the boiler, after it is completed, by bands of soft iron about three-eighths of an inch wide, which are tied with a small buckle.

MR. MARSHALL: I think the tests made by the committee and the results recorded in Figs. 1 and 2 are far from accurate. One of the speakers has referred to some other papers that have been presented on the subject, notably Mr. Norton's; the amount of radiation or loss through all the coverings is very much greater than would appear from the result of these tests by the committee. Furthermore, in looking, for instance, at Fig. 2, you see that all the curves have a tendency to flatten and become horizontal as the test progresses, showing that the loss in radiation from the water into the room had very seriously affected the results. I made a rough calculation on the line which I take in this diagram to be magnesia, and find that the loss by radiation through it to the water on these tests is apparently less than half what it was in Mr. Norton's experiment—one-half to one-third. The inaccuracy of the tests would also seem to be borne out by the fact that wood lagging is apparently one of the best, from these results.

The President: Unless some one rises immediately we will pass this subject.

Mr. McIntosh: I just want to say a word before the subject is closed. Professor Hibbard put a question with regard to our not saying anything about cylinder coverings, or covering the portion of the cylinder saddles that are exposed. If you notice on the bottom of page 4 the committee recommends that all radiating surfaces, where conditions are such that the estimated economy will not be overcome by the inconvenience and expense of removing the same for repairs, be covered. That is the committee's recommendation. The matter of covering the saddles was considered and is practiced by a number of roads. I might mention the Union Pacific and the Chicago & North-Western. Our method is to fill the spaces under the saddle with the plastic material and then put the covering on, sheet-iron covering below that to prevent its becoming detached. We also in some cases have covered that portion of the saddle that lies between the smoke arch and the steam chest, or rather the curve of it, by putting a sheet-iron casing some distance away from the saddle, about two inches, and filling the space with the plastic material.

On motion, the discussion was closed.

The President: Having arrived at the noon hour, the subjects for topical discussion will be taken up, the first subject being "The Special Apprentice," and the Committee on Subjects has notified me that they have asked Mr. Robert Quayle to open that discussion.

Mr. Quayle: I thought that I was to open the discussion on the "Apprentice Boy" rather than the "Special Apprentice" until Mr. McConnell told me to the contrary. However, the special apprentice is becoming a very numerous personage on the various railroads throughout the country, and we begin to think that he is a necessary evil. On the Chicago & North-Western Railway we have a good many special apprentices and we have a number of regular apprentices; and let me say, so that you may not get any strange idea to begin with, that if the regular apprentices possess the same ability to get to the front that special apprentices do, they are not left in the rear by any means. The special apprentice is one who is supposed to come well equipped from a technical school. We have some from Yale, a few from Purdue — more from Purdue than anywhere else, I presume because of the railroad technical training there — and from Wisconsin and Minnesota. Arrangements have been made to put in some others this year. Let me simply call the attention of the Master Mechanics

present to the fact that great advantages accrue to the railroad officer having such men in his employ. When we take the men we give them to understand thoroughly that only on their merit can they expect to succeed and push to the front, and if we have half a dozen — if any one of that half-dozen — if perchance the last of that half-dozen that comes into the employ of the company is a superior man, he pushes at once to the head of the others who have been there a longer period. He must not only have his technical training, he must not only have ability to apply that technical training practically in the shops, but he must have fitness for the work that he has in hand, and he must evidence to us by his ability that he has not only the courage, not only the skill, but the ability to handle men, and to demonstrate this we place him in the different avenues of the various work that we have in the different departments, in order that he may show to us whether he has that proper fitness or not, and then we watch him step by step through his technical training and his practical training as well as his executive ability. We find, as I was about to remark, that they are of great value to us in our different departments, and it relieves the head of the mechanical department a good deal sometimes, when he has men in whom he has confidence, after he maps out a line of experimental work and puts these young men in charge of it and says to them, "I want you to take care of this," and with just a little bit of coaching he conducts the whole work and brings it in and puts it on the mechanical engineer's desk for him to look over before it is presented to the assistant superintendent or superintendent of motive power. You have only ten minutes on this subject, and I want to call your attention to the manner in which this is being conducted on our road and the value these young men are to us, and I would like to call your attention to this fact, that if you will try some of those special apprentices — and it does not cost much, as they come in simply for the experience they will get — you will be highly pleased with the work that you will accomplish by them and through them, and the company as well as yourselves will reap great benefit as the result. [Applause.]

The Chairman (Mr. McConnell): As the time is limited for this discussion, I hope you will all avail yourselves quickly of the privilege of speaking on this matter.

Mr. Tonge: I would like to inquire of Mr. Quayle what rate of pay he gives these special apprentices.

Mr. Quayle: I will answer that by saying that during the last two or three years we started our boys in at 75 cents, but after some

discussion during the last few weeks we have concluded that those boys are worth more to us after they have put in so much time in colleges and received such a fitting education for that work; they are not able to support themselves on that salary, and consequently, to give them encouragement and in order that they may do better work for us, we start them in at $1 per day. [Applause.]

MR. TONGE: Does not this create a disorganized feeling among the regular apprentices — admitting those special apprentices?

MR. QUAYLE: No, sir; we have not found any, because in handling these young men the other young men are given to understand that even though they lack the education, if they have the fitness for the work and develop the proper mechanical skill they have equal chance with the young men who have had a technical education. Therefore every young man is put on his own merit, as you and I are, and if he fails, it is his fault.

MR. BARTLETT: I would like to ask Mr. Quayle if they have no course for those special apprentices except to start them in where they are needed and work them along as they require them. Is that the idea?

MR. QUAYLE: We have no well-defined course for these apprentices, although we are working on that now and have been giving it consideration for three months, and expect to start the new apprentices we are taking in next month on a different basis, although we have not settled on the exact course. But I will say for your information that some of the young men who have not had what we would term sufficient work in the drawing room, we put them in there, and we develop them in that line and on mechanical engineering problems generally, and if they have had sufficient work on that line we put them in the shop and push them on all they are able to take. We put them on the floor first, and from there to the tools. It will depend largely on what their experience has been previously. If they have worked on a testing plant, we put them on that; we put them on testing work in the shop or on the road. We put them on any work that we think will make them efficient mechanics.

MR. MORRIS: I would like to ask what percentage of these special apprentices are sons of employes in the shops, and about what percentage of the regular apprentices are the sons of mechanics in the shops?

MR. QUAYLE: I will have to answer that question in this way: We have one young man we expect to put in shortly, who is the son

of an employe in the shop, and that is the only one, but the major part of them — perhaps ninety per cent of the boys in the shop — are sons of other employes than those in the shop.

MR. MACKENZIE: Mr. Quayle is nicely situated, having this test plant and drawing rooms and other apparatus, to take care of these special apprentices. But it was suggested to me yesterday by one of the professors of our colleges that it would be a good plan to take these boys during their vacation and put them in the shop as laborers or machinists' helpers, and give them a wheelbarrow and a broom. It occurred to me that was an excellent thing. These boys go to school year in and year out and there are three or four months in the year that they do not have anything to do, and if they could be introduced into shops where they have none of these test plants it would be a good thing, I think, if we could do that, and take care of these boys and pay them enough to board them during vacation.

PROFESSOR HIBBARD: I suppose I am responsible for the suggestion to Mr. Mackenzie, and I will say that that has worked out very nicely indeed in the teaching of railway mechanical engineering at the University of Minnesota, which I have just left to come to Cornell, and the Master Mechanics who have had these young men for the long summer vacation have told me in the fall that they liked the work first-rate. They were paying them regular laborers' wages, from $1.15 to $1.25 a day, and they said they fully earned their wages and were profitable employes for the company. They would be put on the erecting side. I don't know whether they had a wheelbarrow, but they were put under the care of a first-class machinist for awhile, and then in the care of another first-class machinist, so that they got a practical acquaintance with the construction of a locomotive in a railroad shop. Then when they came back to the university for some more of their course, perhaps for the last year, they profited by the instruction in railway mechanical engineering in the senior year much more, very much more, than students who had had no practical shop experience at all, and I would say that those students were extremely glad of that opportunity to go in as laborers, as helpers, and it is my dearest hope, perhaps, in coming back here to the East that the Eastern railway shops will be open to the young men who want to get work in the shops for the long summer vacation.

MR. MARSHALL: Mr. Mackenzie spoke of what he would do with these young apprentices where he did not have a testing plant, laboratory, drawing room, etc. I think every Master Mechanic has the

experience of adopting practices or standards on a road or division, and then getting very conflicting reports about them from different points, and these young men, where they have had sufficient shop training to be intrusted with such work, can be sent out to pursue special investigations, resulting in profit to the department and helping them greatly. While Mr. Quayle has not outlined our course for special apprentices, it is one of the features of it that we can use them in this way; in other words, we can assign them to the drawing room or the shop, or some special work around the repair shop, but we expect to have matters so arranged that they can be taken from that work at any time and assigned to special work.

THE CHAIRMAN (Mr. McConnell): Gentlemen, as the limit has expired for this discussion, it will be necessary to pass to the next subject.

Mr. Quayle here took the chair and announced that the next subject would be Topic No. 2: "Is it possible to arrange the front ends of locomotives so they will clear themselves of cinders without throwing sparks?" and stated that the discussion would be opened by Mr. McConnell.

MR. McCONNELL: Gentlemen, in the arrangement of the front ends of locomotives to prevent them from throwing sparks, large sparks, and filling themselves with cinders, it depends a great deal on the condition of the fuel used. On some roads, where you have soft bituminous coal, you can run a coarse netting or perforated grate with large openings, and run the diaphragm pretty well up from the bottom of the smoke arch and have your engine steam freely, clean the front end and still not throw any fire. On some of the Western roads, where the bituminous coal is heavy, I know of engines that are run with netting in the front end, 2 by 2, or half-inch openings. The engines are good steamers and their front ends are perfectly clean. I think the members of the Association will bear me out in this statement, that an engine that steams freely usually keeps the front end clean, and where the front end fills up, the engine does not steam very well, and where it does fill up, the engine is apt to throw fire. Where you use a lignite coal, it is a difficult matter to have the engine clean the front end, make steam and not throw fire. The lignite coal in Wyoming is a good deal of the character of wood, and it requires a very fine netting to prevent the throwing of these sparks. At the same time, the deflecting plate has got to be dropped down pretty well in order to clear the front end, and the exhaust noz-

zles have got to be contracted to overcome the friction of the fine netting and the deflecting plate. In engines that are equipped with diamond stacks, the petticoat pipe can be arranged in such a way that by using low nozzles and setting the petticoat pipe about two inches above the nozzles, placing them about four inches high and leaving about five inches opening on the side of the stack, you can get good results with the Wyoming coal and the engine does not throw very much fire. But when it does, you have got to run a 24-inch cone and give it not to exceed seventeen inches clearance from the barrel of the stack. A number of years ago, on our road, we had the extension front, and we experienced considerable difficulty, we think on account of burning the Wyoming coal, which is lignite in character, and it was found advisable, after about five years' service with them, to remove the extension fronts and equip the engines with the ordinary front end and the diamond stack, and at the present time we are getting good results out of our engines. We run a large nozzle, we steam freely and we do not have very much trouble with fire.

MR. HENDERSON: We have had some little experience with self-cleaning arrangements, and as the idea was originally obtained by us from the Cumberland Valley, and I have a letter here from Mr. J. L. Lawrence, who is a member of the Association and general foreman of the Cumberland Valley, which he has asked me to present to the Association as his remarks, I will read it. The plan which he refers to is illustrated by a blue print. (See Fig. 1.)

CHAMBERSBURG, Pa., June 13, 1898.

MY DEAR SIR,— I regret exceedingly that I cannot attend the convention this year, as I would very much like to have been on hand. I notice among the subjects for topical discussion one concerning the arrangement of front ends of locomotives to clean themselves of cinder without throwing sparks, and as you have by this time had more or less experience with the front end we have adopted, I think it would be nice for you to say something on this question, and you are at perfect liberty to use this feature and also our experience as we give it herewith.

In the first place, we do not know of any extension-front engine that will not throw sparks with the usual grades of bituminous coals, if equipped in the front end in the old way, namely, the diaphragm back of the exhaust pipe and the entire front end provided with netting, if the engine is worked reasonably hard; but with our plan we abolish about forty per cent of the netting, using a solid sheet, and put the diaphragm in front of the exhaust pipe, which seems to give a much better and more evenly distributed draft over the flue sheet and flues. We do not think front appliances can be placed in the front end to keep in the sparks without interfering with the draft and steaming qualities of the engine. But the arrangement should be such

running with nozzles 3½ inches—double nozzle—and you might say there are none of those engines that use that fine coal, what we term buckwheat, that do not run with less than three inches. They vary from 3 inches to 3½ inches, according to the class of engine. The exhaust must be pretty easy with the 3½-inch double nozzle. We use double nozzles altogether. The way we arrange our netting we like to use a low nozzle about eighteen inches high—eighteen to twenty inches high—according to the size of the cylinder part of the boiler, and we bring the deflecting plate down to where the nozzle is put on top of the exhaust pipe proper. We run the netting between the two joints so that the nozzle, where it is fastened to the exhaust pipe—the netting is between the two, of course allowing room to make the joints. In some cases we use a plate below that, back of the exhaust pipe. At other times we will put a plate in front of the exhaust pipe. We would rather have it in front, if we possibly can, if it is necessary to have one at all, because we think it is easier on the steam pipes, leaving it open behind; that is, the sandblast, as you may call it, is not so hard on it, because there are at times impressions on the steam pipes and on the exhaust pipes opposite every flue where the cinders have been impinging there. But we have very good results with the extension fronts. They do not throw much fire and we certainly do not carry much cinders.

THE CHAIRMAN: Gentlemen, we have a gentleman with us who gave me a very interesting account this morning of an engine running into Pittsburg without an exhaust pipe, and which, he claims, does not throw any sparks, and he has promised to confine himself to two or three minutes in telling us what he has.

MR. JOHN Y. SMITH: Mr. President, as you know, I have had many, many years' experience in locomotives of all kinds, burning coke and burning peat and burning coal, in peace and in war. I have done nothing else but experiment on front ends and exhaust pipes. But lately, about three months ago, there came into this young man's head the idea of throwing exhaust pipes away. I made the high grates and low grates and low exhaust pipes, etc., and this apparatus that I made is not an exhaust pipe; it is an apparatus to consume smoke and relieve back pressure, and I have done that thoroughly. We throw no fire whatever. There is not a spark in the fire box. It has been running now nearly three months on all kinds of service on the Lake Erie and Pennsylvania roads, and they do not run trains for fun; they draw iron ore, coke and all that material. We have run

all kinds of heavy trains. A day or two ago Mr. Turner asked me to go on an excursion train with fifteen coaches. A similar engine went out with a train ahead of us. The orders were to let the engines go for all they were worth. The engine ahead of us had, I think, eight or nine cars, and the little boys and girls could not put their heads out of the windows. We came along with about fifteen cars, and all the doors and windows were open. The windows in the locomotive were open and we saw no more dust or smoke in that cab than you see in this house today. That, gentlemen, is a fact. I have no exhaust pipe whatever. I have a discharging head that is about twenty inches in diameter, and by the arrangement of that head I destroy all the smoke, but I produce a positive vacuum. We have no back pressure. We have a pull alternately from each of these exhausts, and it does not cost much. There is nothing that a man can change or alter. We have run it with netting and without netting. Even without netting you never see a spark come out of the engine. That is about all I know about exhaust pipes. [Applause.]

THE CHAIRMAN: Gentlemen, we will declare that subject closed. The next subject is the advisability of a systematic course in engineering in connection with technical schools. Prof. H. Wade Hibbard will open this subject.

PROFESSOR HIBBARD: The committee asked me to open the discussion of the question — the teaching of railway mechanical engineering in technical schools. I consented to do that, and there seems to be a little error in the way the question is stated. I believe that after you have heard what our worthy President has said about the importance of the theoretical education, you will agree that the advisability of such an education, for a railroad man who expects to go up in the railroad service, is unquestioned. If we needed any confirmation of that, it might perhaps be found, if you will remember, in the remarks of perhaps our best-known member, a newspaper man, in one of the railroad clubs a couple of years ago, when he said that fifteen years before there was not a single technical graduate in this Association, and he called attention to the very great amount of evidence that the technical graduates were then and now presenting in controlling and guiding the affairs of this Association. We should be careful not to make the course in railway mechanical education in our schools too broad — so broad as was indicated by some of the discussions in the New York Railroad Club, for instance. There is no possible time for giving that in the four years' course in a tech-

nical school. Of the requirements to enter such a course, I might specifically state that at Cornell University the entrance requirements are that a man should have about a year more of the higher mathematics after graduating from any first-class high school. Then the four years that are left are very largely devoted to the fundamental principles of the profession of mechanical engineering, and it is not until the senior year that much, if anything, can be done in railway mechanical engineering. It is true that in the earlier drawing of, say, the sophomore year, a man who proposed to take up railway work in his senior year may take up his elementary drawing and designing along railway lines. But the senior year is the time when he devotes most of his course to this line, and even in the senior year I do not think it advisable to devote more than half of the time each week to the subject of railway mechanical engineering, including the drawing, designing, testing. A well-rounded course should be insisted on, not a special line of work. There will be a tendency to specialize in the teaching of our railway students, depending upon our equipment — depending upon the previous training of the professor in charge of the work. Care should be taken that they should not specialize that way. The question was asked me recently what proportion of railroad mechanical engineering I considered the locomotive bore to the other branches, and I said perhaps less than one-half. It is certainly the largest single interest. But when we remember the shops and their equipment, when we remember car design, when we remember operation and the various other subjects included in railway mechanical engineering, the locomotive itself is considerably less than one-half, in my opinion, and stress should be laid on the other branches as well as upon locomotive design.

I believe the ideal in locomotive testing should be that we should have two locomotives; a smaller one, which might be called a half-grown locomotive, in a testing plant where the students might gain their first instruction in the testing and in the operation of locomotives — the smaller locomotive enabling them to get more work in a given amount of time and with a given amount of expense. Then there should be a full-sized locomotive, which should be used for thesis work and for investigation, and the results of the tests upon the full-sized locomotive will be of use to the railway fraternity. I think the discussion, perhaps, on this question should follow out these lines: What should be taught? How should it be taught? The teacher's preparation—what may be left out of the regular mechanical course? Now is an especially good opportunity for this Association to make

plain to the technical schools what you want to have taught in the technical schools to a man who is going into railroading. There are one or two schools which have been doing some work on this line. Last year I made a tour of the Eastern technical schools to see what they planned to do, and I find that others, which you do not know anything about, along these lines are trying to go into this work in the near future. Now is the time for you to say what you think ought to be taught to our students and how it should be taught.

THE CHAIRMAN: Gentlemen, let us hear from those of you who have views on the subject.

MR. WAGNER: I would like to have Professor Hibbard explain what is meant here by technical schools. I do not quite see the connection between a systematic course of engineering and a technical school. It seems to me that is what should be taught in all. I cannot see the connection.

PROFESSOR HIBBARD: I made a rewording of the question and put it as it was stated to me in the letter by the committee—the teaching of railway mechanical engineering in technical schools.

MR. SINCLAIR: I feel like taking exception to the last sentence of Professor Hibbard's remarks. If I understand him rightly, he says that this Association should point out what these engineering schools could teach of railroad engineering. Now I think it would be very difficult for anyone in this Association to tell what an educational institution could teach. I think that will have to devolve upon the professors themselves to find out. Take, for instance, trainwork. It is very difficult to see how a school can teach its pupils how to do trainwork unless they have the opportunity to put them on as brakemen or in similar positions. They may give them a few theories about how the work is done and may give them details of mechanism, but they cannot make one of them able to go out and act as an efficient brakeman until he has a lot of practice. He will have to learn it the same as others have to do, and I certainly think it would be for the teachers themselves to find out how far the lines of teaching will extend.

PROFESSOR GOSS: Mr. President, I do not know how much I can say which will be in line with the subject introduced, and which will, at the same time, interest the members. There are several views to be taken of such a subject as this. A large view should prompt us to look upon the work of an educational institution as the work of

drawing out, making larger men. There is a disposition always, when we think of technical work in schools, to connect with that thought the notion of a trade school. Now, the trade school is an important factor in our educational system, I am sure, and in our technical system; but when we speak of our technical schools, of which we have in this country fifty or more, perhaps, we do not think of a trade school, and the purpose of these schools is not to teach trades. It is for that reason we do not train trainmen in connection with our work of railroad engineering. That would belong to a trade school, if we had a trade school in railroad engineering. But we are developing men all the time, and we teach those things which will enable us to develop, to draw out the man, and we teach the things which are included in our course in such a way that the man may not get so many facts — we would like to have him embrace all the facts that come to him — but really that we may teach him to think about facts. Now, it has been developed in the discussion of the special apprentice here this morning that you Master Mechanics, when you take our graduate, do not regard very highly the things which he has learned in school. You do not credit him with being a machinist or an electrical engineer or anything of that sort. We wish you would, we wish you could, but you cannot, and we do not expect you to. You do not value him for the facts that he has obtained, but you do find that that man can do things for you that regular apprentices cannot do; that he can be useful to you in ways that a regular apprentice boy cannot be. He has power of thought and of action which the regular apprentice boy does not possess, and that is power that he has obtained in the technical schools, probably. At least, we will claim the credit for that. So it seems to me that we should keep in mind all the time that we are making men; that most graduates of technical schools, when they are five years removed from their technical schools, do not value very highly the facts they obtained in the school; but they do value the process, the knowledge of methods by which facts may be obtained and their ability to investigate. These principles which they become schooled in are valuable to them. But the real power of doing particular things they do not value when they are very far removed from their course. [Applause.]

Mr. Brangs: I think this is a very important subject. The remarks of our friend here on the schools are going to be a great help to the railroad fraternity, but I do not believe it is possible to make a railroad engineer out of the man from college. It is impos-

sible to take up that branch of special railroad work. I have had a great deal of experience while superintendent of a large concern where there are a great many technical students applying for positions. I found they were entirely unused to and incapable of taking hold of work in a factory, or ordinary shop work. Of course, the education of a technical graduate is of a great deal of use to him. It makes it very hard to think that after he has had four years of thorough education he has to begin at the bottom, but it is the actual fact he has to begin at the bottom. The various branches in which a technical graduate can make his education applicable to the work laid out for him have got to be laid out after he does graduate. It no doubt has been very trying to a great many people to recognize that the technically educated man is to be of great value in all branches of life. As Mr. Goss said, a short while ago, the average shop man has not regarded the technical graduate to the fullest extent. But there is no doubt that we have got to look upon it more so in the future. In all the lines of manufacturing the education of the technical school is beginning to make itself manifest, and I think we can only look at it from this standpoint as it is. The young man can get his education in college and then he has got to fit himself for whatever work is laid out for him, whether it be locomotive engineering, mechanical engineering or electrical engineering, and I think that the four years is enough to give a college graduate a proper sphere in any one particular line of work.

Professor Hibbard: Mr. President, while agreeing most entirely with the remarks that have been made as to the making of a man capable of taking hold of work in a better way, because he has had a technical education, giving him the facility to think and to concentrate his thoughts, to know where to find information, how to pursue an investigation, how to discern truth from fiction in what he is trying to do, I also believe that much can be done in the way of giving him information as to the good and bad points of present design, and if I may proceed I will read a word:

"The object is to give a better understanding of present defects and of the scientific principles that come into play — a wider knowledge of what has been practiced by others, past improvements with their extraordinary results and historical direction or promise, and the methods by which similar defects have been overcome in kindred branches of engineering. The good and bad effects of various designs are pointed out, following their record through the builders',

operators', testers' and repairers' experience as given in practical designing for the student, never losing sight of commercial considerations of cost, kind of material and its market shapes, ease of construction in the shops, simplicity and interchangeability and all the various considerations of daily use and of repair. In short, such methods with proper modifications for purposes of construction as have been followed and found most successful in shop drafting management. The testing of railway equipment and locomotives in the laboratories of the road is carried on for the instruction of the students by the most approved method that will afterward be found practically useful in railroad service."

I will also add with regard to Mr. Sinclair's remarks, perhaps definitely laying down some of the courses which are planned for Cornell University for the advanced work in railway mechanical engineering, after the subject of rolling stock has been taken up in its design, construction, operation and maintenance, will come lectures and directed reading, taking up shop arrangements, uniformity of methods, government of labor, drafting-room management, railway testing, organization, methods and records of motive-power department, foreign railway equipment and compound locomotives, freight-car designs and such other subjects as there may be still left a limited time for.

THE CHAIRMAN: Gentlemen, we have about five minutes. Are there any other remarks on this topic?

MR. WAGNER: The outline that Professor Hibbard gave us of what the technical course of railway engineering should consist of reminds me of a course that I had outlined for a technical night school. I am afraid that he will find in a few years that it is entirely too broad, and I think, with respect to the subjects outlined, members will agree that that is too much, and I rather think that when we have disciplined the students for many years in mathematics and mechanics we have accomplished nearly all that we can for the four years without going into all these various practical problems which the professor has enumerated.

MR. JOHNSON: Mr. President, I have listened with a great deal of pleasure to the discussion of this matter, but it seems to me the gentlemen are getting on rather too broad lines. In the first place, the question was sprung some years ago, and the object was that of higher education. The object was that a young man would be sent to college to get a first-class training in mathematics — the higher as well as the ordinary branches. He would there acquire a knowledge

of how to apply the mathematics in a scientific manner for the purposes of testing, etc. But so far as the practical part of the technical schools is concerned, handling tools, etc., I am afraid that when the question is put to the individual, he will find that it will be of very little practical service. I have had the pleasure of handling several gentlemen who have passed through technical colleges, and one especially bright young man, one of the finest mathematicians I ever saw in my life, asked me one day why it was I did not put him on the floor. I said, "John, if I put you on the floor, what can you do?" "Well," he said, "I ran a lathe for nearly two years in a technical college." I said, "Have you specimens of your work?" He said, "Yes, sir." Then he went to his hotel and came back with a few cones, some bolts and other things. I said, "Those are very pretty." The next morning I put him on a link lathe and gave him a block pin to turn up. I need not tell you, gentlemen, that it took him eleven hours to turn up the block pin. I said to him, "John, you took eleven hours on that block pin. That apprentice boy will turn it out in three." I moved him from there to the wheel lathe and gave him a set of 60-inch wheels to turn out. He was forty-one hours completing the job. They were beautiful, I will admit, beautifully finished things; but this served to show the practice which they receive at college is not applicable when it comes to the business of a machinist or of a tool hand. But as a conductor of tests and a keeper of accounts and a leader for those who have not had his high mathematical education, he is valuable, and that is where we expect to apply his knowledge. But as far as the practical part is concerned, there is no royal road to learning. You must get it on the ground. [Applause.]

THE CHAIRMAN: The hour is up, lacking one minute, and I just want to call attention to one thing — that you must not think for a moment that these young men who come into our shop come there with any notion, after we get through talking to them, that there is any royal road to their success. After receiving a technical education, they come into the shop to receive their practical education. They begin the same as any other man.

The hour is up, and the topical subjects are closed.

MR. WAITT: As it is one o'clock, I move that we adjourn until the usual hour tomorrow morning.

MR. BRIGGS: I would like to amend that and make it that we adjourn at two o'clock.

**The President**: It is moved and seconded as an amendment that we continue in session until two o'clock, which is practically the same as voting down the motion that was made to adjourn, inasmuch as our By-Laws adjourn us at two o'clock. As many as are in favor of the amendment, please signify by saying "aye"— contrary minds, "no."

The motion was lost.

**The President**: Now the original motion is before you, to adjourn to meet at nine o'clock tomorrow morning. As many as are in favor of that motion will signify by saying "aye"—contrary minds, "no." It is carried.

The meeting then adjourned until the following day.

## SECOND DAY'S PROCEEDINGS.

The convention was called to order on Tuesday, June 21, at 9:15 A.M.

**The President**: As there is not quite as good an attendance as we may expect a little later, I think it will be well to take up the sixth subject, the report of the Committee on Square Bolt Heads and Nuts, and Standards for Pipe Fittings. Inasmuch as there will probably be no discussion, I would like to hear the report of that committee. Messrs. Herr, Quereau and Marshall are on that committee. I do not think Mr. Herr or Mr. Quereau is in the audience. I would ask Mr. Marshall if he will read the report.

Mr. Marshall read the following report:

### REPORT OF COMMITTEE ON SQUARE HEAD BOLTS AND NUTS; STANDARDS FOR PIPE FITTINGS.

*To the President and Members of the*
*American Railway Master Mechanics' Association:*

Your committee on "Standard Pipe Fittings and Square Head Bolts and Nuts" jointly with Master Car Builders' Committee find it necessary to report progress and ask to be continued for another year. After meeting and conferring with the similar committee of the Master Car Builders' Association last fall it was deeided that the object for which these committees were appointed could not be attained without concerted action of the members of the principal

societies of mechanical officers. Your committee therefore addressed the following communication to the American Society of Mechanical Engineers:

"ST. PAUL, MINN., November 16, 1897.

"Subject: Lack of uniformity in sizes of pipe unions, etc.

"*Secretary American Society Mechanical Engineers, 12 West Thirty-first street, New York:*

"DEAR SIR,—The attention of the American Society of Mechanical Engineers is directed to the lack of uniformity in the sizes of pipe fittings manufactured by different makers in various parts of this country.

"This has been brought forcibly to the attention of the undersigned and others interested in the mechanical department of railway work, by the trouble, delay and consequent expense caused by pipe unions, purchased from different dealers for the same purpose, not being interchangeable. The same also is true of pipe threads themselves, although the lack of uniformity is not so great. This subject has been deemed of sufficient importance by the American Railway Master Mechanics' Association and Master Car Builders' Association for the appointment of a joint committee on this and the related subject of standards for square bolt heads and nuts. Inasmuch as the desired uniformity can only be secured by concerted action of the large purchasers and consumers of bolts and nuts, pipe and fittings, and those engaged in their manufacture, it would seem desirable that the American Society of Mechanical Engineers should, at the next meeting, appoint a committee to consider these subjects, confer with the committees of the railway associations, and endeavor to secure the appointment of a committee representing the manufacturers, with the object of securing the desired uniformity.

"As an example of the present condition of affairs, the diameter and number of threads on union nuts of one-inch pipe fittings made by seven different manufacturers are given below:

| No. Threads. | Diameter of Threads. |
|---|---|
| 11 | 2.000 inches. |
| 12 | 1.875 " |
| 11½ | 2.000 " |
| 11½ | 1.97 " |
| 12 | 1.875 " |
| 11½ | 1.8906 " |
| 11½ | 2.1718 " |

"Yours very truly,

"E. M. HERR,<br>
"WALDO H. MARSHALL, } Members A. S. M. E.,<br>
"CHAS. H. QUEREAU,

*Committee.*"

This was presented at the New York meeting of that society held November 30 to December 3, 1897, and the following resolution passed:

"*Resolved,* That the American Society of Mechanical Engineers, having received and considered the suggestion of Messrs. E. M. Herr, W. H. Marshall

and C. H. Quereau on the subject of securing uniformity in the threads of coupling unions for pipe, approve of the suggestion that the society should appoint a committee to consider this question in joint conference with similar committees of the American Railway Master Mechanics' and Master Car Builders' Associations, and refer the appointment of such committee to the council with power."

On April 7 last a joint meeting of your committee and that of the American Society of Mechanical Engineers was held in New York and a plan agreed upon which it is believed will accomplish the object for which your committee was appointed. This will require considerable time as it includes designing a complete line of standard pipe unions which can only be satisfactorily done after taking the matter up with the principal manufacturers of pipe fittings and giving careful consideration to this side of the question.

We are advised by the chairman of the Master Car Builders' committee which is taking up specially the matter of standard square bolt heads and nuts, that final action on this subject will also have to be deferred until next year.

Your committee, therefore, finds it necessary to ask to be given more time in which to complete the work assigned to it.

Respectfully submitted,

E. M. HERR,
W. H. MARSHALL,
C. H. QUEREAU,
*Committee.*

ST. PAUL, MINN., May 21, 1898.

THE PRESIDENT: Gentlemen, you have heard the report of the committee. What is your pleasure?

MR. MITCHELL: I move that the report be accepted and the committee continued.

The motion was carried.

THE PRESIDENT: Gentlemen, listen to the Secretary on the report of the Auditing Committee.

MR. CLOUD:

*To the Members of the American Railway Master Mechanics' Association:*

The Auditing Committee has examined the books and vouchers of the Secretary and the Treasurer and found them correct.

JOHN MACKENZIE,
A. M. WAITT,
W. H. MARSHALL,
*Committee.*

MR. HENDERSON: I move that the report of the Auditing Committee be received.

The motion was carried.

THE PRESIDENT: The Secretary has some matter on his desk which I will ask him to read.

MR. CLOUD: An effort has been made to secure free transportation by the Day line from Albany to New York, and in response thereto a message was received by Mr. Schevers, as follows: "We cannot honor Central passes, but I have issued instructions to our agent, Elmendorf, Albany, to issue passes to your delegates holding same" (that is, New York Central passes), "and we will be happy to have your members use this line on returning from Saratoga.—F. B. Hibbard." Mr. Schevers then asked him if he would also include the D. & H. invitation cards, and the answer to that is this message: "We will include the D. & H. cards. This message will be your authority for Mr. Elmendorf.— F. B. Hibbard."

THE PRESIDENT: Gentlemen, I think now is as good a time as any to state that in accordance with usage, although our Constitution or By-Laws do not provide for it, we will appoint Messrs. Sinclair, Mitchell and Lewis a committee on correspondence and resolutions to report to this convention before we close.

MR. MITCHELL: Mr. President, I leave Saratoga this noon for New York, and it is impossible for me to serve on that committee.

THE PRESIDENT: Then we will substitute Mr. Waitt. We have some proposals for associate membership, and as there is scarcely any use in taking up these reports until there are more here, especially those who are chairmen of committees, I will ask the Secretary to read them.

MR. CLOUD: These are proposals which will come before the Association at a future convention, to be voted on:

We, the undersigned, hereby propose for associate membership in this Association Mr. Richard A. Smart, Associate Professor of Experimental Engineering, Purdue University. (Signed) A. M. WAITT.
TRACY LYON.
WM. FORSYTH.

The Chair has appointed a committee on this application to report to the Executive Committee prior to the next convention, as follows: G. R. Henderson, W. H. Marshall, Peter H. Peck, L. R. Pomeroy.

We, the undersigned, propose Mr. Strickland L. Knease, of William Sellers & Co., Ltd., as an associate member of the American Railway Master Mechanics Association.
P. LEEDS.
W. F. M. GOSS.
R. QUAYLE.
W. S. MORRIS.

The Chair has appointed a committee to report to the Executive Committee on this application prior to the next convention, as follows: A. E. Manchester, William Forsyth, W. H. Lewis (Norfolk & Western Railway).

We do hereby propose that Mr. Clement F. Street, M. E., manager of the *Railway Review*, be elected an associate member of the American Railway Master Mechanics' Association.

W. H. LEWIS.
J. H. MCCONNELL.
A. E. MITCHELL.

The Chair has appointed a committee on this application to report to the Executive Committee prior to the next convention, as follows: William Garstang, G. W. Cushing, John Hickey.

MR. HENDERSON: Mr. President, as we are waiting here indefinitely, I would like to call attention to the fact that it seems to some of the members that the method of collecting the dues during the regular sessions takes a great deal of time and is rather an antiquated method. I would like to ask if there is any objection to its being done in the regular way of sending the amount by check through the mail, and have the receipts sent by mail? It seems to me a rather incongruous method. I would like to ask if the Secretary thinks there would be any diminution in the finances of the Association if the other method was adopted?

MR. CLOUD: I would say to Mr. Henderson that at every convention since I have been Secretary I have discouraged the paying of dues at the convention as much as I possibly could, and have only taken them because they were thrust upon me, and I have encouraged the payment of the dues by check on receipt of bill. It would be a great relief to the Secretary, I am sure, whoever he may be, if such a plan could be followed.

MR. SINCLAIR: I have had considerable experience in collecting money for the American Railway Master Mechanics' Association, and I found that a great many people would pay at the convention when they would not pay at any other part of the year, however many bills might be sent to them. There are a good many members of the Association who are not at all zealous about paying their dues, and some of them come to the convention with a little more money than they have to spare at other times in the year, and you could get the money from them then when you cannot get it at other times. Another thing in my experience was that certain parties would be away back in their dues, and a personal interview had a great deal of

influence in getting them to pay up, and a personal interview could be had here better than anywhere else. So I should certainly advise you not to try to discourage the payment of dues at the convention.

MR. FORSYTH: Mr. President, if this matter of the collection of dues is still in order, I move that the matter be referred to the Executive Committee with the object of arranging some improved method of collecting dues over the present one.

The motion was seconded by Mr. Henderson, and carried.

THE PRESIDENT: We will resume the reports. We passed Nos. 2 and 3 yesterday, and would like to take up No. 2 now, as "Advantage of Improved Tools in Railway Shops," if Mr. Gentry is in the audience. Mr. T. R. Browne, will you please take that up in Mr. Gentry's absence?

MR. BROWNE: Yes, sir. I will not take the time to read this report, as I presume you all have read it over——

MR. MANCHESTER: Mr. President, I do not believe we all have read it over. I would like to hear it read.

MR. BROWNE: Well, I will say by way of preface, that your committee, after thinking over this matter, considered that it covered a very much broader and wider field than simply the question of making out a list of certain improved tools which it would be an advantage to use in connection with railroad work; in other words, that those tools should be used in connection with advanced methods of administration, and appreciating the fact that they have a maximum capacity which could be got out of them in connection with railroad work, in a similar manner as if the same competition existed in manufacturing railroad articles as exists between manufacturers of similar articles competing in the open market. That subject is so wide and so broad that your committee did not have the time to cover it properly, and as they felt they should, and they respectfully submit the following:

## REPORT OF COMMITTEE ON ADVANTAGE OF IMPROVED TOOLS FOR RAILROAD SHOPS.

*To the President and Members of the*
*American Railway Master Mechanics' Association:*

Your committee appointed at our last convention to inquire into and report on this subject has found it a very difficult matter to get accurate and reliable figures as to the saving in dollars and cents over the old methods by the introduction of improved tools in our railroad shops. It finds, however, that where a careful selec-

tion and proper application has been made of improved tools in shops the saving in time over the old methods of getting out the same class of work is so great as to set aside all doubt and beat down all prejudice heretofore existing in the minds of a few mechanical men who are loth to depart from old and tried ways. Your committee finds that the introduction of truly improved tools for meeting special railway repair shop work has been slow, considering the great advantages derived from their use, and from facts ascertained in making its inquiries, it is satisfied that a large majority of our Master Mechanics are not reading up on or keeping posted with the progress made by some of their brothers in this important line, or if they are, then their managements fail to appreciate their efforts, or act upon their suggestions.

As your committee on the subject of motors, in their full and complete report at our last convention, covered this field so well, this committee decided not to touch to any extent upon this part of what is considered by many as pertaining to our subject of improved tools; at the same time we want to emphasize and indorse all the committee suggests, and to add that even since their report was submitted rapid strides have been made in the invention and introduction of powerful and convenient motors having electricity and compressed air to actuate them, and with the advantages of being adapted to special or universal service which enables them to cover almost every variety of work for which detached or independent motion is desirable, and the extended use of them in connection with the latest improved tools designed to work with them is strongly urged by your committee. The great improvement made in heavy shop tools and the very successful efforts to introduce features in them for wider scope and greater capacity is familiar to all who have looked into the subject, and your committee assumes, in the matter of heavy lathes, planers, slotters, shapers, etc., that all interested are posted, and proposes to confine its report to the more special tools, those gotten up with a view of dispensing with all work formerly done by hand where possible to machine it.

These are the great labor and time savers, and consequently do as much, and in some cases more, to reduce cost of repairs on locomotives than the heavy tools, and, strange to say, they have received but little attention in proportion to their worth, if we may judge from the lack of general introduction. These consist in part of milling machines, vertical, horizontal and universal. Turret lathes of special design, special brass lathes, grinding machines, tool-sharpening devices, cold sawing and cutting off machines, threading machines for turned bolts, etc., to dispense with cutting threads on lathes, and some of the latest designs of light shapers, slotters and quick return planers.

Possibly the most important of the improved tools are the latest designs of milling machines. With these we are enabled to machine almost any part of locomotive machinery that cannot be handled in our lathes and planers, and also finish and fit parts that could only be done by hand heretofore, and owing to their ease of adjustment we are enabled to design work to be machined by milling very cheaply that would have been difficult if not impossible to handle in any other machine. A visit to some of the large building shops where heavy milling machinery has been so generally introduced would be quite a revelation to those who have failed to keep up with the subject. There seems to be no limit to their usefulness, and but few, if any, jobs arise in ordinary practice that cannot be handled in a well-designed milling machine. Your committee finds that the introduction of light milling machines years

ago, which could be used only for cutting gears, fluting reamers, taps, etc., and which proved too small to be of any general use, had the tendency to prejudice many shop men against them, and the fact that only recently such machines as are calculated to take the place of planers, slotters and other tools have been available has, no doubt, had much to do with the slowness of shop managers to take hold of them, but now that it is possible to select a machine to suit your work, we strongly recommend their use, and find that a saving of at least twenty per cent over the ordinary planer can be obtained where a heavy milling machine is worked up to its full capacity on most work.

Perhaps the next most important, if not equal, adjunct in the way of improved tools for machine shops is the turret lathe. These tools are now made very strong and heavy, designed to cover a large variety of work, and for nearly all kinds of turning from the solid bar.

With a properly built turret lathe not only are bolts for engine work, but all pins, bushings, collars, etc., for any description of machinery, rapidly produced, and accurately duplicated. The attachment for threading makes them much faster and more accurate than the old method of threading in ordinary lathes. Your committee recommend none but the best and heaviest turret lathes. There are many on the market like the poor milling machines, and not worth the room they occupy. Too much care cannot be exercised in selecting what are considered improved tools for shops, and this applies with great force to tools for railroad shops, where we cannot afford many, if any, costly special tools, but must confine ourselves to purchasing such improved, or even ordinary machines that are as universal as possible in their action. We find that with their best designs of turret lathes in the hands of smart and intelligent operatives who adapt the machines to the work in hand, and work them to full capacity, that a saving of from forty-five to fifty-five per cent can be obtained in all kinds of bolt and pin work, over the ordinary method of doing this work in lathes.

Your committee finds that great improvement has been made in the machinery for handling brass work in shops, and notwithstanding we are constantly trying to reduce, or dispense with connections and attachments as far as possible, we still have a large number of brass and other metal fittings to produce, and all shops that are prepared, or desire to make their own oil cups, gauge cocks and standard brass fittings would do well to look into the matter. Many of the best of these machines will lessen the cost of production of this class of work at least fifty per cent, and the output is far superior in fit and finish, owing to the arrangements for accurate duplication.

There are now available several makes of quick-return high-speed planers and shapers for light work, designed to keep all small jobs out of the heavier tools, and where a shop is confined to two or three planers, all of them probably 36-inch or over, with one or more heavy shapers, one of these machines will be found not only very convenient, but most profitable. They handle rod keys, liners, keys for frames, etc., and for quick time on brass work of all kinds are indispensable. These newer designs are small, but heavy and compact, and should not be confounded with the flimsy little machines so generally on the market, with which all shop men have become disgusted, owing to poor design, extreme lightness and uncertainty of feed, etc.

Your committee is pleased to note the more general tendency on the part of many

shop men to take advantage of the suggestions made and points given in former reports of committees on this subject. It encourages us to hope our efforts are appreciated, and that good is being done by the Association's action in keeping this most important matter to the front. This is especially apparent in the number of pneumatic and electric motors in use, and particularly the former. We find but few shops who now depend upon the old ratchet for drilling and reaming, and the number of belt and rope conveyors, and old-fashioned devices for obtaining motion, are growing less every day. We find that where compressed air is being used in connection with the best motors for drilling, reaming, boring, tapping, chipping, caulking, screwing in staybolts, riveting tanks, ash pans, and many other uses, that the average saving over the old hand methods is from thirty-five to forty per cent, and on some jobs is over fifty per cent, particularly in drilling where ratchets were formerly used. The average saving in boiler shops fully equipped with good pneumatic tools to cover all lines where they have proven an advantage is about fifty per cent, and by some who have given the matter much thought is considered much above this figure when great saving in time engines are laid up for boiler work is counted.

We find fewer improvements in our blacksmith shops than in other departments of railroad works, the old methods prevailing in them to a much larger extent than in others, and we suggest to our Master Mechanics and foreman blacksmiths to go around, or write for particulars as to what is being done in this line at some of our leading railroad shops, those of the Union Pacific at Omaha, the Santa Fe at Topeka, and many others which have introduced compressed air with great results on certain work.

Outside the shop proper, in the yards and buildings for storing material and scrap iron, is a great field for saving labor by conveniently arranged pneumatic lifts and motors, many foremen being able to do with two or three men what kept ten or a dozen busy, such as loading and unloading wheels, tires, boiler plate, heavy castings and lumber. In addition to the saving in time, the liability to accidents to employes is greatly lessened by the safer and surer manner of handling and the fewer men employed. Your committee could not procure figures showing the relative economy of these yard appliances, but their ultimate saving must be apparent to all.

We find a great improvement in many of the woodworking machinery departments of our railways. This is particularly true of those shops who build a part of their new equipment. The improvement in planing and matching machines, borers, mortisers, sawing machines, and in fact all woodworking machinery, has been so rapid in the past few years as to be a question "if it would not pay many roads to dispense with the whole of their antiquated old plant and replace it with just half as many well-selected tools designed for their work, that would turn out more work in a day than they now get out in a week."

Before concluding its work on this subject, the committee desires to call the attention of our Association to a few things that have struck us most forcibly while inquiring into the matter:

First, the great difference existing in the methods of prosecuting work, even on improved tools in the average railroad shop, as compared with a well-organized and hustling manufacturing establishment in about the same line of business. The factory producing for the market to make a profit seems actuated throughout by a

different impulse from the average railroad shop, even where piecework has been long established, and none of the railroad shops seem able to get quite as much advantage of their special improved tools as is accomplished in the factories—in other words, they are not worked up to their capacities as continually. We have, of course, made due allowance for the difference actuating the employes, and the difficulties to be met by foremen and others in our railroad shops, and we simply mention this in connection with the economy of improved tools.

Second. In some shops we found milling machines that were idle which could have been well adapted to many kinds of work being done in planers, shapers and slotters; these would have been greatly relieved and much other work done in them that the mill could not handle by proper management and suitable cutters being provided for the mills. No pains should be spared to provide every device for utilizing the milling machine to its fullest capacity and keep it going all the time. When once realized its great usefulness cannot be overlooked, and its place is never filled by any other machine.

Among other improved tools that seem to contribute largely to the increased output of such shops as have taken advantage of them are the cold sawing machines. These are used for cutting-off machines, and also for cutting to given lengths all kinds of shapes, rounds, squares, flats and ovals of almost any section, evening up channels, tees, angle irons, etc., and also cutting them to given lengths with great ease and rapidity as compared to old methods. These machines are almost indispensable in the building of iron and steel tender frames, trucks, etc., and for the boilermaker they supply a long-felt need, while they contribute to every department around a work. None but the heaviest and best should be introduced; the great scope of their work entitles them to the closest consideration in selecting shop plants, and we invite special attention to them. A reasonable estimate of their saving over old methods is about thirty-five to fifty per cent, according to character of work to be done, and with them all cross-sections such as are met in tender frame construction are made perfect.

The committee has not touched upon shop cranes as yet; it almost hesitates to do so, as so few ordinary repair shops are able to provide them. At the same time we all admit the desirability of their extended use. A large majority of the older shops are so arranged as to prevent the use of overhead traveling cranes, but the introduction of electric motors has made it possible, where the change can be afforded, for some of our railway shops to erect them. Where this cannot be done the work can be greatly facilitated by putting up at needed points the best forms of chain hoists in connection with pneumatic lifts, etc., as in the case of other improvements mentioned. A visit to some of the shops where this has been done will assist greatly in giving an idea of what can be done to do away with the old plans of "main strength and awkwardness" so prevalent in many shops that have lots of work to do. They are the greatest time and labor savers that we have, and their importance cannot be overestimated.

It has been suggested to your committee that a more proper subject for consideration in this line would have been "the advantages of modern tools and modern methods in railroad shops," for the reason that there is opportunity for a larger

proportionate saving in the ordinary well-equipped plant by changes in methods than by the adoption of the latest tool which may be on the market.

Respectfully submitted,

T. W. GENTRY,
JOHN PLAYER,
T. R. BROWNE,
*Committee.*

MR. MITCHELL: I move that the report be received and opened for discussion.

The motion was carried.

THE PRESIDENT: It is before you now for discussion.

MR. GAINES: Mr. President, I remember one case in which a milling machine was tested against a planer. In one of the shops in which I worked at one time, we had recently got a large, heavy milling machine, and, being one of the few men who had ever run such a machine, I was put on that machine. We also handled a large amount of coal and breaker work, and one day we had a large number of shafts which had to have key-ways cut in them, and we decided to test the milling machine against the planer, and we found that the milling machine did it in half the time, and that did not include the drilling of a hole in the shaft for the clearance on that planer.

PROFESSOR HIBBARD: Mr. President, this seems to me a very important subject, because we find such a difference in the operation of modern tools in the railroad shop and in the contract shop, and I wish I might emphasize that part of the committee's report that we need, if possible, to make use of our modern railroad tools on the contract-shop method. It would be a question, perhaps, how we can attain to the contract-shop method. Of course, we have our work coming into the railroad shop in a different way to contract-shop work, but I believe very much can be done in the way of following contract-shop methods, and these methods can be obtained, not so well by inspection — that is, by the motive-power officer going to the contract shop and seeing what is done there — as by having some one or several in his railroad shop who have had contract-shop experience. If, perhaps, your special apprentice class could have numbered among them some young men who had learned their trade in a contract shop, and know the hustling methods of a contract shop, they would introduce great saving in the railroad-shop

methods. In speaking about milling machines, I am always glad to remember the experience that I had in the Rhode Island Locomotive Works, when I was learning my trade, with a vertical-spindle milling machine of the heaviest type — Hill & Jones machine, I think it was — and the amount of work which we could turn out on that machine was astonishing. I would go in at seven o'clock in the morning, and find work which had been piled up in front of the milling machine, and piled around it so that I could hardly get at it by even working overtime the previous evening, and it would be only a short time before that floor would be cleared. The enormous amount of work that that machine could accomplish was surprising to me. In looking around among the railroad shops I find that, although the milling machines have been introduced very largely, yet the vertical-spindle milling machine of the heavy type has not been introduced so largely as I wish it were.

On motion of Mr. Sinclair, the discussion was closed.

THE PRESIDENT: We will take up Subject No. 3, "Best Form of Fastening for Locomotive Cylinders." Mr. Henderson, are you familiar with this subject? Have you had any conference with Mr. Sanderson?

MR. HENDERSON: I have had some conference with Mr. Sanderson about it, but I think Mr. Sague has some ideas in opposition, and I think it would be well to wait until he gets here.

THE PRESIDENT: Then I will call on Professor Goss to take up Subject No. 5, "Efficiency of High Steam Pressure for Locomotives."

PROFESSOR GOSS: A word of explanation is due the membership concerning the form of this report. At a meeting of the committee, held soon after its appointment, it was agreed to divide the subject into several subtopics and to assign these various topics to the individual members of the committee. As a result, four papers have been presented, which appear in this publication as appendices to this report. They present, first, a discussion of fundamental facts involved in the problem of high steam pressure; second, steam pressures in marine practice; third, increase of pressure and cost of locomotive repairs; fourth, tests under different steam pressures, and fifth, boiler pressure *vs.* boiler capacity. Now, each one of these subjects is treated more or less completely in its place. The report proper, from which only I will read, is really only a summarv of the conclu-

sions reached by these several separate discussions. I will not read all of the report, though it is brief, but will begin a little above the middle of the second page.

Professor Goss then presented the following report:

## REPORT OF COMMITTEE ON EFFICIENCY OF HIGH STEAM PRESSURE FOR LOCOMOTIVES.

*To the President and Members of the*

*American Railway Master Mechanics' Association:*

1. At the time this committee was appointed, it was expected that the experimental locomotive at Purdue University would serve to give sufficient data to permit the presentation of a report dealing entirely with experimental facts. Unexpected delays have been met and the problem has proven to be an extensive one. While more than thirty tests have been run, the full significance of the data obtained cannot be known until it is supplemented by information yet to be supplied. For this reason it has been thought best to withhold the experimental data thus far obtained until the investigations shall have developed definite conclusions. Some reference may, however, be made to the tendencies disclosed by the work already accomplished and a general discussion of the question may be introduced.

2. The locomotive with which the two Stephensons competed for and won the prize at Rainhill carried a steam pressure of fifty pounds per square inch.* This was seventy years ago. Since the time of the Rocket, the pressure on locomotive boilers has been gradually increasing, and today practice in America involves the use of pressures which fall between the limits of 140 pounds and 200 pounds. While many locomotives are running under pressures which are near the lower limit, few are now being built which are designed to carry less than 180 pounds and a pressure of 200 pounds has ceased to be uncommon. What lessons are to be derived from the experiences of the past, and to what extent are they to be relied upon to guide the practice of the future? Will the tendencies which have manifested themselves in the past continue to prevail? Are we to look for a gradual increase beyond 200 pounds, or has the maximum limit already been reached? These are the important questions which naturally suggest themselves in connection with the subject which is to be presented by this report.

3. POWER AND EFFICIENCY.—The power developed by a locomotive is a measure of the work done by the steam in the cylinders; it is a function of pressure, steam distribution, diameter and travel of piston, and of speed. The efficiency of a locomotive is a measure of the degree of perfection attending the development of power; concisely stated, it is the ratio of the heat equivalent of the work done in the cylinders, to the heat supplied the fire box. That locomotive is most efficient which, for each pound of coal burned, develops the largest amount of power in the cylinders.

Anything which affects the efficiency either of the boiler or of the engines of a locomotive affects the efficiency of the locomotive as a whole. Boiler efficiency

* Smiles' "George and Robert Stephenson," page 217.

depends upon the proportions of the boiler and the rate of power to which it is worked, while engine efficiency depends upon many factors of which initial pressure is but one. Whatever gain in efficiency is to be derived from the use of higher steam pressure in locomotives is, therefore, to be found in the improved performance of the engine. An ideal engine will always give increased efficiency in return for increase of pressure, but the actual engine may or may not do so. (Appendix I.)

While the term "efficiency" should not be confused with "power," these terms express facts which, in a locomotive, are closely related. Under normal conditions, a locomotive is worked so near its maximum power that the limit of power is determined by the amount of coal it can burn. If improvement can be had in the process of combustion, or in the more complete absorption of heat by the heating surfaces, or by a reduction in the amount of fuel lost as sparks, the efficiency of the boiler will be increased, and at the limit of power this improvement in performance can be converted into an increase of power. Again, if the cylinders can be made to better utilize the heat supplied them, they may with a given amount of steam be made to yield greater power. It is safe, therefore, in summarizing these statements to say that anything which will operate to improve the efficiency of a locomotive may be employed as a means for increasing its power. If, therefore, increased pressure increases efficiency, it is clear that every interest will be served by its adoption.

4. Pressure a Single Factor Affecting Efficiency.— There can be no question but that the gradual increase of pressure which has been developing itself for many years past has been accompanied by increased engine efficiency. It is, however, probably true that much of the improvement which has been observed is the result of betterments in mechanism, as well as of advance in the direction of pressure. This fact makes it desirable to emphasize at this point a matter to which brief reference has already been made, namely, that pressure constitutes but a single factor affecting the performance of an engine. Equally important with pressure are questions of valve proportions and of valve setting, of cylinder clearance, and of degree of expansion. Moreover, the significance of all of these factors is increased as the pressure is increased. Great improvement in efficiency, therefore, should not be expected as the result of attention given to the matter of pressure alone. On the contrary, it should be assumed that each increase of pressure is a demand for greater refinement in the mechanism of the engine. The valve action must be positive and must give a good distribution of steam at short cut-offs; the cylinder clearance must be minimum, the extent of surface bounding the clearance volume must be held to its lowest limits, and as pressures increase, compound cylinders must be used. With such attention to details, it is probable that each increase of pressure will be found to contribute its share to the progress of the future. (Appendix IV.)

There are those who view the situation today with the feeling that increase of pressure, being rather easily obtained, has advanced more rapidly than other measures affecting the efficiency of the locomotive. They assert that time must be had in which to perfect other details before further advances in pressure are made. If this position is true, it is likely that as in marine practice an advance in boiler pressures awaits a general adoption of the water-tube boiler, so in locomotive practice a further advance in pressure awaits the more general advent of the compound engine. (Appendix II.)

It is frequently assumed that the process of gradually increasing pressure beyond limits now common will soon reach a point beyond which it will be found impracticable to go. Difficulties in maintaining a satisfactory condition of lubrication, in using soft metal packing, and in using water glasses under pressures which much exceed 200 pounds are often cited in this connection. It would appear, however, from experience already had in marine work, that none of the difficulties are such as will block the way to the adoption of higher pressures whenever it shall be demonstrated that higher pressures are needed to further increase the efficiency of our locomotives.

5. HIGH PRESSURE ON SIMPLE LOCOMOTIVES.— The term "high pressure," as employed in this paragraph, refers to pressures above 160 pounds. The effect of such pressures on the performance of non-compound locomotives is now to be considered. The arguments for and against their adoption may be summarized as follows:

| IN FAVOR OF HIGHER PRESSURES. | AGAINST HIGHER PRESSURES. |
|---|---|
| 1. Smaller cylinders, and consequently lighter reciprocating parts. | 1. Increased weight of boiler. |
| 2. Reduced width of engine outside of cylinders. | 2. Increased first cost of boiler. |
| 3. Reduced first cost of engine. | 3. Increased transportation charge, due to increased weight of boiler. |
| 4. Reduced transportation charge because of reduced weight. | 4. Probable increase in small heat losses, as from radiation and from leakage past valves and glands. |
| 5. A possible gain in the efficiency of the engine, whereby a given power is developed on less steam and on less fuel than could have been done with a lower pressure. | |

It is assumed that, other things being equal, the evaporative efficiency of the boiler will not be changed by such modifications as are necessary to enable it to withstand increase of pressure; the evaporative efficiency does not, therefore, appear as a factor on either side of the argument.

It is assumed also that cost of lubrication and of repairs to boiler and engine do not necessarily change with changes in steam pressure. (Appendix III.)

Reviewing the arguments as summarized above, it is to be noted that the important factor favoring the adoption of higher pressure is the possible economy which is expected to result. The other advantages are incidental, and while some of them may have great weight in particular cases, their significance in the general case merits but slight attention.

The economy which is to result from an increase of pressure must be sufficient to balance all of the considerations which in the foregoing summary appear against the adoption of such pressures. It is evident that unless the gain in efficiency is material, the net result of increasing pressure will be disappointing.

In this connection it will be profitable to review briefly the results of tests run under different pressures on the experimental locomotive of Purdue University. This

locomotive carries 250 pounds pressure; its cylinders, having been constructed for special investigation, have an unusually large clearance, and at the time of the tests the valve setting gave excessive lead at very short cut-off. It is significant that these defects were sufficient in their effect to more than neutralize the gain which might otherwise have resulted from the use of higher pressures. It is, in fact, so easy to fail in securing the anticipated gain from increase of pressure, through some minor defect of design or of adjustment, as to make it probable that the most economical pressure for simple engines, in their present stage of development, is within the limits of present practice. (Appendix IV.)

6. HIGH STEAM PRESSURES FOR COMPOUND LOCOMOTIVES.— It has already been argued that compounding is a means to the economical employment of high steam pressures, from which it follows that the maximum pressure for compounds is higher than for simple. Existing data is insufficient to serve as a basis for any prediction as to the effect of successive increments of pressure upon the efficiency of compounds of existing types.

7. HIGH PRESSURE AND ENGINE DIMENSIONS.— As is well known, the volume of the cylinders of an engine which is to develop a given power is, other things being equal, inversely proportional to the available pressure. As the steam pressure is increased the size of the cylinders may be reduced. On many roads, the width of engines over cylinders is already very close to the clearance width along the right of way. On such roads a demand for engines of greater power cannot be met by increasing the diameter of cylinders; hence, resort must be had either to a longer stroke of piston or to higher steam pressure. Demands of this nature will unquestionably stimulate a tendency to the employment of higher pressures, and the end will justify the means.

8. BOILER PRESSURE *vs.* BOILER CAPACITY.— It is not the purpose of this report to enter upon a general discussion of conditions affecting locomotive efficiency, but the question of boiler pressure is so closely associated with that of boiler capacity that a brief reference to the latter subject seems desirable.

The preceding discussion discloses the fact that the proposition to improve the economy of a simple locomotive by increasing pressure beyond present limits is of doubtful value. When viewed as one of several expedients which are open for adoption, it is manifestly not of first importance. For example, within limits now common, an increase in boiler capacity offers a way to increased efficiency which is both sure and significant. If, for example, it is desirable to increase the efficiency of a locomotive now carrying 140 pounds of steam, by giving it a new boiler of the same dimension with the old, but designed for a pressure of 200 pounds, the effect produced will be entirely due to increase of pressure. The economy resulting cannot be large, and may, as in the case of experiments already cited, amount to nothing. The new boiler may weigh, approximately, 5,000 pounds more than the old. Now, it can be shown that if, instead of adding to the weight of the locomotive by making a *stronger* boiler, the same increase of weight had been applied to making a *larger* boiler, the resulting economy would not fail to be material. (Appendix V.)

WILLIAM F. M. GOSS,
WILLIAM FORSYTH,
TRACY LYON,
*Committee.*

# APPENDICES

## TO THE REPORT ON EFFICIENCY OF HIGH STEAM PRESSURES FOR LOCOMOTIVES.

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## I.

### FUNDAMENTAL FACTS.

(*a*) A brief review of some of the more important facts relating to the use of steam at different pressures is herewith presented (Table I):

TABLE I.

| Gauge pressure. Pounds. | Temperature of. | Increase in temperature for each 25 pounds increase in pressure. | Total heat in one pound of steam above the heat of freezing water — B. T. U. | Increase in thermal units in one pound of steam for each 25 pounds increase in pressure. | Pounds of steam per I. H. P. per hour required by a perfect engine. Back pressure, 1.3 pounds. | Thermal units per I. H. P. per hour, required by a perfect engine. | Decrease in thermal units per I. H. P. per hour required by a perfect engine for each 25 pounds increase in steam pressure, expressed as a per cent. |
|---|---|---|---|---|---|---|---|
| I. | II. | III. | IV. | V. | VI. | VII. | VIII. |
| 25 | 266.6 | ......... | 1163.28 | ......... | 39 40 | 36888 | ........... |
| 50 | 297.5 | 30.9 | 1172.61 | 9.33 | 26.25 | 23791 | 35.4 |
| 75 | 319.8 | 22.3 | 1179.51 | 6.90 | 21.57 | 19227 | 19.1 |
| 100 | 337.6 | 17.8 | 1184.94 | 5.43 | 19.53 | 16955 | 11.8 |
| 125 | 352.7 | 15.1 | 1189 47 | 4.53 | 17.54 | 15185 | 10.4 |
| 150 | 365.7 | 13.0 | 1193.54 | 4.07 | 16.45 | 14084 | 7.30 |
| 175 | 377.3 | 11.6 | 1197.04 | 3.50 | 15.62 | 13242 | 5.97 |
| 200 | 387.8 | 10.5 | 1200.17 | 3.13 | 15.00 | 12599 | 4.85 |
| 225 | 397.3 | 9.5 | 1203.14 | 2.97 | 14.51 | 12067 | 4.22 |
| 250 | 406.1 | 8.8 | 1205.77 | 2.63 | 14.17 | 11636 | 3.57 |
| 275 | 414.2 | 8.1 | 1208.27 | 2.50 | 13.74 | 11255 | 3.27 |
| 300 | 421.8 | 7.6 | 1210.57 | 2.30 | 13.39 | 10927 | 2.93 |

(*b*) THE RELATION OF TEMPERATURE AND PRESSURES is shown by Columns I and II, and the rate of increase of temperature for equal increments of pressure, by Column III. It will be seen that when the pressure is low, a small change in pressure produces a marked change in the temperature, but when the pressure is higher, changes in pressure have less effect upon the temperature. For example, changing the pressure from 25 to 50 pounds produces an increase of temperature of 31 degrees, while changing the pressure from 275 to 300 pounds produces an increase of temperature of only 7.6 degrees. It is interesting to note, also, that a pressure of steam as high as 300 pounds involves temperatures which are only a

little higher (34 degrees) than those which are already dealt with in locomotive service as a result of pressures of 200 pounds.

(*c*) TOTAL HEAT.—The amount of heat which must be expended to change a pound of ice-cold water into steam at the several pressures named is shown by Column IV. The values in this column are in British thermal units. The amount of heat needed to produce 25-pound increments of pressure is shown by Column V. It will be seen that practically it costs no more to make steam at 150 pounds pressure than to make it at 100 pounds.

(*d*) STEAM CONSUMPTION OF A PERFECT ENGINE.— From theoretical considerations, it is possible to define the performance of a perfect engine working between any stated limits of pressure. No actual engine can ever give a higher performance than that of the perfect engine, but there is no *theoretical* reason why the performance of the actual engine should not approach and even equal that of the perfect engine. This fact makes the performance of the perfect engine a convenient basis upon which to measure the performance of actual engines. Again, it is often assumed that the effect of a change in steam pressure on the performance of

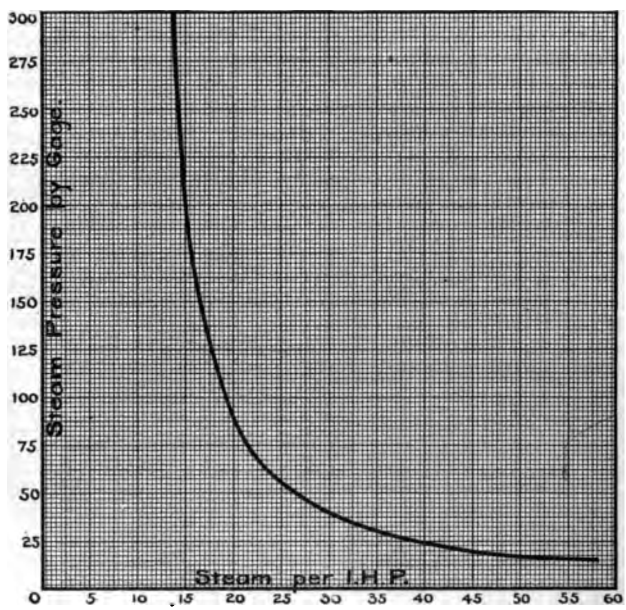


**FIG. 1.**
STEAM CONSUMPTION OF A PERFECT ENGINE.

any actual engine will be proportional to the similar effect produced in the performance of the perfect engine by the same change in pressure; so that, if the performance of an actual engine under one pressure is known, its probable performance

under any other pressure may be predicted. Such a process is subject to limitations, and is one which can never be depended on to give results with absolute accuracy, but the relation between the actual and perfect engines is sufficiently close to warrant attention in this connection.

Column VI shows the weight of steam required by a perfect engine when the pressure of exhaust is 1.3 pounds above the pressure of the atmosphere, and the initial pressure that shown in Column I. This relation, also, is shown graphically by Fig. 1. Values in Column VI may be compared with similar values derived from actual engines, but since each pound of steam contains an amount of heat varying with its pressure, they do not fairly represent the relative efficiency of the ideal engine under different pressures. A perfectly logical basis from which to judge the effect of different pressures is, however, supplied by Column VII, in which the performance is expressed in terms of thermal units, and by Columns VIII and IX, which show the decrease in the consumption of heat for each 25-pound increment of pressure.

Two important facts are to be noted in this connection. One is that every increase of pressure results in a definite reduction in the amount of heat consumed per unit of power. It is this fact which is fundamental in any argument favoring increase of pressure. The second is that the rate of change diminishes as the scale of pressure is advanced. Thus, increasing the pressure from 25 pounds to 50 pounds reduces the heat consumption of the ideal engine 27 per cent, while an equal increment of pressure from 275 pounds to 300 pounds affects the performance of the ideal engine 2.9 per cent. It is evident from this statement of facts concerning the performance of the perfect engine, that chances for improving engine economy through increase of pressure have been greater in the past than they are likely to be in the future. Assuming the present limit to be 200 pounds, the possibility of improving efficiency through increase of pressures alone are not so great as when the limit was 100 pounds.

W. F. M. G.

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## II.

## STEAM PRESSURES IN MARINE PRACTICE.

(*e*) Marine engineers, aided by circumstances which permit the highest development of the steam engine, have been quick to avail themselves of all the more important conditions which contribute to high efficiency. Aided by high steam pressure, by economizers, by multi-cylinder engines and by condensers, they are able to secure a horse-power on a fuel consumption exceeding but a trifle over one pound of coal per hour, which is about one-fourth the amount required by a locomotive under most favorable conditions. These circumstances suggest that the locomotive designer may well be interested in such details of practice as relate both to his own work and to that of the marine engineer. Such a detail is to be found in the practice with reference to steam pressure.

The general practice in marine engineering provides for a boiler pressure of about 175 pounds, with occasionally examples of higher pressures up to 200 pounds. The latter figure is considered the practicable limit for shell-boilers of large size.

Further increase of pressure depends upon the possibility of obtaining a boiler which shall be suited both to high pressures and to general marine conditions. There is a strong tendency to replace shell boilers by water-tube boilers. Especially is this true in naval work, where weight is an important factor, and in yachts of high speed. Where water-tube boilers are used, they commonly carry a pressure of from 250 to 300 pounds, but for the general conditions of trans-ocean traffic the water-tube boiler, in its present forms, has not yet commanded sufficient confidence to insure it a definite standing in this field.

It is significant that while marine engineers are generally alive to the advantages to be derived from high pressures, they have not seen their way clear to utilize pressures which exceed those now common in locomotive service.

W. F. M. G.

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## III.

## INCREASE OF PRESSURE AND COST OF LOCOMOTIVE REPAIRS.

(*f*) *One* of the prime difficulties in arriving at any very definite conclusions upon this subject lies in the fact that the greater number of the locomotive boilers now carrying the higher steam pressures have been in service but a comparatively short time. It is the opinion of some of the best authorities that no conclusive evidence bearing upon the maintenance of locomotives carrying high boiler pressures can be now presented. It should be noted in this connection that by "high pressure" is meant pressure approaching 200 pounds, and by "low pressure" pressures between 140 and 160 pounds.

While much trouble has been had from some of the earlier boilers carrying 200 pounds steam pressure, in that their construction was to a certain extent experimental, there seems to be no reason why boilers cannot be built to successfully carry such a pressure. A materially increased weight must be looked for, a thickening of the plates and a more substantial staying and riveting; but this being done, it would seem to be established by close observation that the repairs of a boiler, properly designed for the service, are directly as the horse-power of work performed, irrespective of the pressure carried. It has been suggested that the increased temperature of the fire-box sheets, due to an increased temperature of the steam, might injuriously affect the material, and that therefore it is desirable that the steel used in high-pressure boilers should be chosen and treated with special reference to its behavior under such conditions.

Passing to the question of the repairs to the machinery of the locomotive, it is difficult to find any evidence tending to show that other than the main valves, valve seats and valve gear, cylinders and piston rod and valve stem packing, are affected by high steam pressures. There seems to be no question but that higher steam pressures mean increased wear of the valves and seats, and possibly of the link motion, due to the drag of valves even as well-balanced as the ordinary slide valve may be. This is of course directly due to the pressure, in combination perhaps with the difficulty of obtaining sufficient lubrication with the present oiling devices, especially at high speed and short stroke. Those who have used piston valves appear to consider that they

meet the requirements of high pressures much more nearly than any other form. The cylinders and piston packing rings are also probably affected by the severer service (see Proceedings, A. R. M. M. Association, 1897, page 197) as well as the boiler mountings. Rod packing of soft metal may be melted by the higher temperature of the steam with which it comes in contact and harder mixtures required.

One railroad reports the performance of ten engines carrying 200 pounds pressure, in service from eight months to one year, as compared with the same number of engines carrying 150 pounds pressure, in service for from ten to fifteen months, the figures given being for four months only.

Cost of running repairs per engine-mile:

High-pressure engines, $1\frac{82}{100}$ cents. Average monthly mileage, 5,139
Low " " $1\frac{18}{100}$ cents. " " " 3,529

An increase in the running repairs of the high-pressure engines as compared with the low pressure of 12 per cent. Even here, however, the engines carrying the high pressure are much the heavier, and upon a ton-mile basis, instead of a train-mile, the balance is the other way.

It is evident that the available data are too meager to admit of any positive conclusions, but it seems the more probable that the use of high steam pressures need not be attended by any considerable increase in the cost of repairs.

T. L.

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## IV.

## TESTS UPON LOCOMOTIVES AT DIFFERENT PRESSURES.

Tests under different steam pressures in the laboratory of Purdue University have involved two locomotives, which with the results obtained from them are briefly described as follows:

(*g*) Schenectady No. 1 is an eight-wheeled engine, weighing 85,000 pounds and having 17 by 24 inch cylinders. Unpublished data embrace three tests of this locomotive, for which all conditions, excepting that of pressure, were the same. All three tests were run at a speed of, approximately, thirty-five miles an hour, at a cut-off of about one-third stroke, and with a wide-open throttle. These conditions of speed and cut-off were those which had previously been determined as giving the maximum efficiency. A summary of the data for these tests appears in Table II.

## TABLE II.

SHOWING THE PERFORMANCE OF LOCOMOTIVE SCHENECTADY NO. 1 UNDER DIFFERENT STEAM PRESSURES.

| Consecutive number. | Laboratory designation. | Revolutions per minute. | Miles per hour. | Throttle position. | Reverse lever, notch forward of center. | Cut-off, per cent of stroke. | Boiler pressure by gauge. | Initial pressure from cards. | Increase of initial pressure. | Percentage increase of initial pressure. | Indicated horse-power. | Increase of power. | Percentage increase of power. | Pounds of steam per horse-power per hour. | Decrease in steam consumption. | Percentage decrease in steam consumption. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I. | II. | III. | IV. | V. | VI. | VII. | VIII. | IX. | X. | XI. | XII. | XIII. | XIV. | XV. | XVI. | XVII. |
| 1 | 35-2-B | 188.4 | 35.0 | Wide open. | 2d | 32 | 98.4 | 91.5 | .... | .... | 300 | .... | .... | 28.8 | .... | .... |
| 2 | 35-2-A | 190.0 | 35.3 | " | 2d | 32 | 131.7 | 115.6 | 24.1 | 26 | 435 | 135 | 45 | 26.3 | 2.5 | 9 |
| 3 | 35-2-C | 189.5 | 35.2 | " | 2d | 32 | 143.3 | 137.3 | 21.7 | 19 | 522 | 87 | 20 | 24.9 | 1.4 | 5 |

**NOTE.—The boiler pressure for the second test is in doubt, and as at the time this test was run there were no facilities for checking this pressure, there is now no way to verify it. The *initial* pressures, however, are from cards which afford ample opportunities for verification, and for this reason the initial pressure is used as a basis for comparison in the table, rather than the boiler pressure.**

It appears from the table that changing the pressure from 91.5 pounds to 115.6 pounds, an increase of 24 per cent, increases the power 45 per cent, and diminishes the weight of steam required per horse-power per hour 9 per cent. Again, changing the pressure from 115.6 pounds to 137.3 pounds, an increase of 22 per cent, increases the power 20 per cent and reduces steam consumption 5 per cent. The steam consumption per horse-power per hour plotted in connection with a curve representing the performance of a perfect engine, appears in Fig. 2. The actual engine is represented by the curve *a b*, and the perfect engine by the larger curve. This diagram emphasizes two important facts; first, that there is a reduction in the steam consumption of the actual engine, when the pressure is increased; and second, that the rate of change is very nearly proportional to the calculated rate of change for the perfect engine.

This latter relationship is important, since it is often assumed to be a general one, so that if the steam consumption for an engine at any pressure is known, its consumption for other pressures may be definitely calculated. The location of the

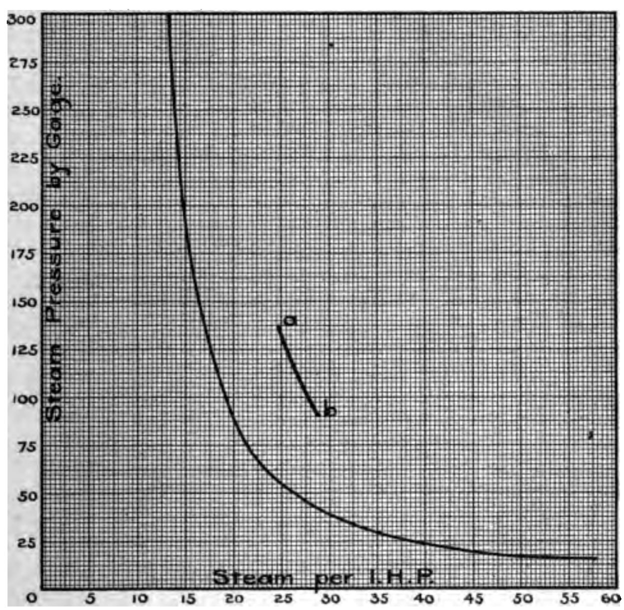



FIG. 2.

**The steam consumption of an actual locomotive is shown by the line *a b*, which is to be compared with the longer curve showing the consumption of steam by a perfect engine.**

curve *a b* (Fig. 2), shows that the actual engine consumed about 50 per cent more steam than would have been required by a perfect engine. This percentage is, approximately, constant within the limits of the experiments, and goes far to sustain the generally accepted theory already referred to.

Assuming that the relation of the steam consumption of an actual engine will bear a fixed relation to that of a perfect engine, we may extend the curve of performance given in Fig. 2. Such an assumption implies that had it been practicable to run higher pressures on Schenectady No. 1 without making any change in the proportions or adjustment of the engine, the steam consumption for the different pressures would have followed the line *a c* (Fig. 3). That is, with a boiler pressure of 150 pounds the consumption would have been slightly in excess of 24 pounds per horse-power per hour, while for 300 pounds the consumption would have fallen below 20 pounds.

It is, however, to be noted that while theoretical considerations go far to justify dependence upon the curve *a c*, as representing the probable performance of the locomotive in question under different pressures, it is after all an assumed curve. The curve *a b*, Fig. 2, expresses a fact; the curve *a c*, Fig. 3, represents for a greater range of pressures a probable relationship.

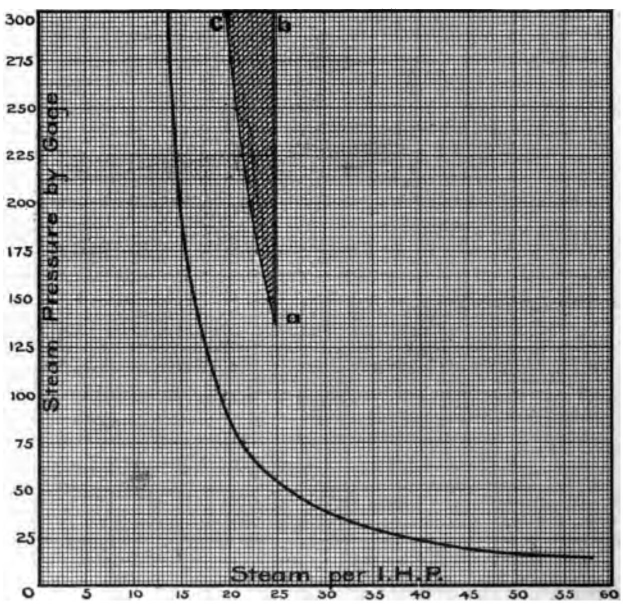



**Fig. 3.**

Assuming that at a pressure of 138 pounds an actual engine requires 24.8 pounds of steam per horse-power per hour, the amount which a similar engine will require when supplied with steam at higher pressures will, if plotted on this diagram, fall within the shaded area *a b c*.

(*h*) SCHENECTADY No. 2.— It is evident that the maximum pressure which could be carried on Schenectady No. 1 was too low to admit of experiments under different pressures which could be depended upon to guide future practice. As a result of

this condition and of a desire to further investigate the question of high pressures, as well as to give facilities for research along kindred lines, the Purdue authorities have recently provided a new locomotive, known as Schenectady No. 2.

This locomotive has a boiler of approximately the same dimensions with that of No. 1, but one which is capable of withstanding a working pressure of 250 pounds. The boiler is 52 inches in diameter, has 1,300 square feet of heating surface, and 17 square feet of grate surface. The cylinders at present in service are cast 20 inches in diameter by 24 inches stroke, and have valves and ports suited to these dimensions, but to adapt them to the work under discussion the cylinders were bushed to 16 inches diameter.

Tests were planned in six different series for which pressures of 90, 120, 150, 180, 210 and 240 pounds were chosen. Each series was to consist of three tests for which the reverse lever was to be respectively in the third, sixth and tenth notches from the center forward, giving cut-offs of, approximately, 25, 33 and 40 per cent. It will be seen that the plan provided for eighteen tests for which the variables were pressure and cut-off. All other conditions were to be constant. The throttle was to be wide open, and the load for each test such as would hold the engine at a speed of forty miles an hour.

The execution of this outline was intrusted to Prof. Richard A. Smart, from whose report the following facts are summarized:

In attempting to carry out the tests specified, it was found that the power developed by the engines at the chosen cut-offs was considerably greater than had been expected, a result doubtless due to the combination of large ports and bushed cylinders. At the chosen speed of forty miles an hour, the mean effective pressure was so high, even at the shortest cut-off embraced by the outline, that when the boiler pressure was above 180 pounds the capacity of the boiler was not sufficient to supply the cylinders. It was necessary, therefore, in order to maintain higher pressures with a wide-open throttle, either to reduce speed or shorten the cut-off. The latter expedient was chosen.

It may be noted also as a matter of interest that when this group of tests had been run, a second group was undertaken at the same speed and same cut-offs, but under different degrees of throttling, the boiler pressure varying between 120 pounds and 240 pounds. In all thirty-four tests have been made.

The results, while entirely consistent one with another, and doubtless accurately representing the performance of the engine, are not in all respects such as were looked for. They show, as was expected, that the steam consumption is lowered when the pressure is increased, but they also show that the lowest steam consumption of Schenectady No. 2 was much in excess of that required by Schenectady No. 1. The best performance of No. 2, which was designed for a maximum pressure of 250 pounds, was below the best performance of No. 1, which was designed for a maximum pressure of 140 pounds.

This general result is to be traced chiefly to differences in cylinder design. As already noted, the cylinders of the new engine were cast 20 inches in diameter, with ports proportioned to this dimension, but for the present experiments bushings were inserted, reducing the effective diameter to 16 inches. This arrangement gives an amount of cylinder clearance which is nearly 50 per cent greater than that of the normal

locomotive cylinder, and an area of surface bounding the clearance space which is very much larger than that which would bound the clearance space of a normal 16-inch cylinder. It happened, also, that the valve setting, while not bad for any test, could have been made better for those tests which were run under short cut-offs and higher steam pressures.

In explanation of the valve setting, it should be said that before beginning the work, the valves were set to give maximum efficiency at the chosen cut-offs. After some of the tests had been run, it was found necessary, as already stated, to run others at a shorter cut-off than had been planned, and for these short cut-off tests the valve setting gave too much lead. As the running and working up of tests involved the interests of students to whom parts had been assigned, it was deemed inexpedient to reset the valves for the shorter cut-offs, and, as a result, the tests at very high pressures were run under a condition of valve setting known to be defective.

It is estimated that the defective valve setting may have increased the steam consumption per horse-power per hour under the conditions which prevailed for some of the tests as much as one pound, while the excessive clearance, and conditions incident thereto, appear to have affected the steam consumption to the extent of 3 or 4 pounds. It is evident, therefore, that the data obtained from tests under consideration will be of greater value in a study of cylinder clearance than in a study concerning high steam pressures. For the latter purpose they are, in fact, misleading unless all of the conditions affecting the tests are taken into account. It is for this reason that the data derived from the experiments are not presented in detail.

Incidentally it should be added that while the data do not serve the present purpose, they are nevertheless of great value, since when fully interpreted they will disclose the significance of an element in locomotive design, the importance of which has not yet been fully appreciated.

The data also justify the conclusion that any increase of pressures is not in itself a guarantee of improved performance. The improvement in performance which is to be expected from small increments of pressure is so small as to be quickly neutralized by any minor defect of design or of mechanism. This fact is expressed graphically by Fig. 3, in which the curve *a c* may be accepted as representing the best performance to be expected from any simple locomotive, while *a b* is a line of constant steam consumption. No ordinary locomotive, when working under most efficient conditions, should be expected to require more steam than is indicated by this line. It is fair to assume, therefore, that the weight of steam per horse-power per hour required by an ordinary simple engine, in good order, when working under most efficient conditions will, if plotted with boiler pressure, fall within the shaded area of Fig. 3.

Concerning the behavior of engine and boiler under high pressures, it should be said that no difficulty arising from defective lubrication of valves, or from any other cause which might be attributed to the employment of high pressures, was experienced in running tests of 100 miles with no stop, and with the throttle always wide open, under a boiler pressure of 240 pounds. The work at all times proceeded with regularity.

W. F. M. G.

# V.

## PRESSURE VS. CAPACITY.

(*i*) It may be assumed that the efficiency of a locomotive may be increased either by increasing the pressure on the boiler or by increasing the size or capacity of the boiler. If the pressure is increased, the gain is to be found in the improved performance of the engines; if the pressures remain unchanged and the boiler is made larger, its evaporative efficiency, when developing a given power, will be increased. Either an increase in pressure or an increase of capacity involves greater weight, and as the cost of a boiler of any given type will be approximately proportional to its weight, the whole question may be resolved into the following statement, namely: Shall any added weight which may be given the boiler of a locomotive be devoted to increasing its strength that a higher pressure may be carried, or to increasing its capacity that it may render its service while working at a correspondingly lower rate of power? The following paragraphs present some facts bearing on this question:

TABLE III.

SHOWING CHANGE IN WEIGHT OF BOILER WITH STEAM PRESSURE.

| Steam Pressure. | Weight of 60-inch Boiler. | Weight of 52-inch Boiler. |
|---|---|---|
| I. | II. | III. |
| 140 | ..... | 21035 |
| 150 | 33121 | ..... |
| 180 | 35253 | ..... |
| 210 | 38513 | ..... |
| 240 | 39035 | ..... |
| 250 | ..... | 25775 |

(*j*) PRESSURE AND WEIGHT OF BOILER.—Table III gives, in Column II, the weight of a 60-inch boiler suitable for a Mogul or ten-wheeled engine designed for different pressures varying from 150 to 240 pounds. The values given in this column are estimates supplied through the courtesy of the Baldwin Locomotive Works. Column III of the same table gives weights of the boilers of the Purdue experimental locomotives, No. 1 and No. 2 respectively, which are in every way similar, excepting that one was designed for a pressure of 140 pounds and the other for a pressure of 250 pounds.

It will be seen that an increase in steam pressure from 150 to 240 pounds in a 60-inch boiler necessitates an increase in weight of 5,900 pounds or of 18 per cent, and that an increase in steam pressure from 140 to 250 pounds in a 52-inch boiler necessitates an increase in weight of 4,700 pounds or of 22 per cent. It will, therefore, be sufficiently accurate for our purpose to assume that a change of pressure from 150 pounds to 240 pounds, an increase of 90 pounds, will necessitate an increase in weight of boiler of about 20 per cent. The benefit to be derived from such an increase of pressure may be judged by reference to other portions of this

report. (Appendices I and IV.) We may next inquire as to the probable effect of converting the 20 per cent increase in weight into increase in capacity.

(*k*) EFFICIENCY AND CAPACITY.—The evaporative efficiency of a boiler depends on the rate of power to which the boiler is worked. The relation of efficiency and power, as defined by a large number of tests made upon the boiler of Schenectady No. 1, at Purdue, is shown by Fig. 4. It will be seen that when the power is such

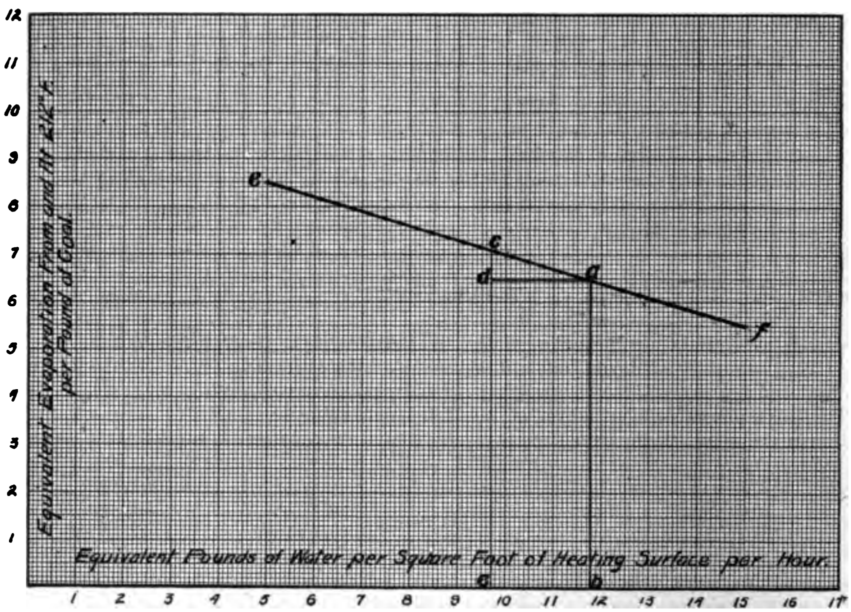



FIG. 4.

as will require 5 pounds of water to be evaporated per foot of heating surface per hour, 8½ pounds are evaporated for each pound of coal burned; but when 15 pounds of water must be evaporated per foot of heating surface per hour, only 5½ pounds are evaporated per pound of coal. Strictly speaking, the relationships disclosed by Fig. 4 apply only to the boiler from which they were derived, but as all locomotive boilers of usual form may be expected to give a curve of the same general character, that which is presented may be employed as the basis of the following general illustration. Thus, suppose that the demand for steam upon what may be called a "normal" boiler is such as to require the boiler to work at the point *a* on the curve of efficiency. If, now, the same demand for steam is supplied by a boiler whose heating surface is greater than that of the normal boiler, the larger boiler will work at some point, *c*, higher on the curve of efficiency; the increase in efficiency will be represented by the ratio of *c d* to *a b*. An inspection of the figure will show that the value of the ratio depends upon the length of the line *d a* and upon the location

along the efficiency curve of the initial point $a$. That is, the increase in efficiency depends, first, on the amount of increase of heating surface, and, second, on the rate of evaporation of the assumed normal boiler.

Numerical values, based on the assumption that increase in capacity will be proportional to increase of weight, are given in Table IV.

TABLE IV.

SAVING IN FUEL BY USING A BOILER WHOSE CAPACITY IS GREATER THAN AN ASSUMED NORMAL BOILER.

| Pounds of water required to be evaporated per square foot of heating surface per hour in a normal boiler. | Percentage saving in fuel by using a boiler whose capacity is greater than the normal boiler, by 5, 10, 15 and 20 per cent, respectively. | | | |
|---|---|---|---|---|
| | 5 per cent. | 10 per cent. | 15 per cent. | 20 per cent. |
| I. | II. | III. | IV. | V. |
| 5 | 0.8 | 1.5 | 2.2 | 2.9 |
| 6 | 1.0 | 1.9 | 2.8 | 3.7 |
| 7 | 1.2 | 2.3 | 3.4 | 4.5 |
| 8 | 1.5 | 2.9 | 4.1 | 5.3 |
| 9 | 1.8 | 3.4 | 4.8 | 6.1 |
| 10 | 2.0 | 3.9 | 5.5 | 7.1 |
| 11 | 2.3 | 4.5 | 6.4 | 8.2 |
| 12 | 2.7 | 5.1 | 7.4 | 9.4 |
| 13 | 3.0 | 5.7 | 8.4 | 10.7 |
| 14 | 3.4 | 6.4 | 9.4 | 12.0 |
| 15 | 3.8 | 7.4 | 10.6 | 13.6 |

Table IV. shows that the saving which results from increasing the capacity of a boiler is most marked at high power. Thus, an increase of 20 per cent in the size of a boiler increases the evaporative efficiency only 2.9 per cent under a development of power which would be supplied by the normal boiler, by an evaporation of five pounds of water per foot of heating surface per hour, but increases to 13.6 per cent when the power is increased threefold.

It is perhaps fair to presume that the heating surface, or better, the steam-making capacity, of a boiler of any given type may, within limits, be proportional to its weight. The improvements in efficiency recorded in Column V of Table II are such as may be expected to result from such an increase of size as would produce a 20 per cent increase in weight, the boiler pressure remaining the same. These values (Column V) compared favorably with the possible gain in efficiency to be derived from an increase of pressure alone (Appendix I), and while the gain from increased pressure must for the present remain a matter of some speculation and doubt, that which is to be had through increased capacity is both certain and fixed.

W. F.

THE PRESIDENT: Gentlemen, you have heard the report. What is your pleasure?

MR. JOHNSON: I move that it be received and spread upon the minutes.

The motion was carried.

THE PRESIDENT: It is before you for discussion.

MR. HENDERSON: Professor Goss, the chairman of this committee, asked me to open the discussion on this report, and as there are several points in it that I am glad to see brought out, I will touch on them briefly, with a view more particularly of encouraging further talk on the subject.

At the top of page 3 we see a statement that increase of pressure demands greater refinement in the mechanism and adjustment of the engine, and in this connection we would like to call attention to the general tendency of making longer ports and greater valve travel, which we think is in the right direction, and it has been recognized in some quarters that steam of higher pressure needs larger ports for its unrestricted flow, as the resistance to motion will be greater with the increased pressure. The largest ports which we have come across in a single expansion engine, at present, are those used on some of the Pennsylvania locomotives, the ports being 23 inches long for a cylinder 19 inches diameter. Of course this leads to large valves, which must be carefully balanced and cored to make them as light as possible.

On page 4, at the top, it is stated that the cost of repairs to boiler and engine does not necessarily change with variations in steam pressure, but I think most of us will agree that there is more difficulty in keeping boilers using high steam pressure in serviceable condition than those in which the pressure is below 150 pounds. It is stated in the fourth paragraph of the same page that the economy which is to result from increased pressure must be sufficient to balance all the adverse considerations, and we think that this is especially true as locomotives are used at the present day. With longer runs and shorter time at terminals, simplicity of construction and want of repairs have economical features, as great, possibly, as a fair saving fuel, and this factor cannot be ignored by the motive power department of a railroad, much as they would like to get the coal bills down. Anything that will require the detention of the locomotive either on the road or at terminals is a positive disadvantage, and our experience has been that high pressure engines need almost continual work done on boilers in order to keep them in a serviceable condition. More

especially at the present day economical operation does not necessarily mean a great amount of work done by a small amount of fuel, but more frequently a great amount of work done by a small number of engines; or, in other words, the quantity of work done by a locomotive is of more importance than the economy in fuel shown by the same locomotive. Now, if the engine can be arranged so that it will require the least time upon its maintenance, instead of having so many dollars' worth of locomotives in the roundhouse and until it comes out, it is practically useless to the railroad company. Then again, there are cases in which the actual working time of the locomotive when it is doing useful work is a small percentage of its time away from terminals, and we know of some recent cases in which heavy locomotives used in pusher service work usefully but one hour out of eight or ten on the road, and in cases like this the economy of fuel is certainly a very small advantage to the engine, but the hauling power of the engine is of the greatest value. If, therefore, the high steam pressure enables us to pull more loads, that is what is wanted; but if it will enable us to save only a small percentage of fuel and the engine will be detained in the roundhouse longer for boiler repairs, it will not be a desirable state of affairs. The fact called attention to in the last part of the fifth paragraph, that some minor defects of design or adjustment will render useless the gain due to increased pressure, speaks very strongly in favor (under present conditions at least) of keeping the limit of simple engines to about 200 pounds per square inch.

At the bottom of page 9 the power used in moving the slide valves under high pressure is spoken of, and the piston valve is referred to as being more suitable for high pressure than any other type. We think this is correct, as we have had between thirty and forty engines with piston valves in use for five years with very satisfactory results. These valves, moreover, enable us to get a larger port, which will give a prompt admission of steam without unnecessary wire drawing, and can be arranged to do this without excessive clearance.

On page 17 Diagram 4 is of considerable interest, and by comparing it with Diagram 4 of last year's report on "Grate Area and Heating Surface" we find a remarkable conformity which further confirms our belief that the diagrams of last year's report, just mentioned, can be used with accuracy in estimating the performance of locomotives in advance of their construction.

The table on page 18 is also extremely interesting, showing what can be accomplished in the way of larger boilers in preference to

increased steam pressure. The report on "Grate Area and Heating Surface" of last year is very conclusive that larger boilers are economical in fuel, and in making some recent investigations into the speed at which the maximum power of a locomotive would be developed, we were forcibly struck with the fact that larger boilers will not necessarily enable a locomotive to exert any greater tractive power at slow speed, but will increase the speed at which the maximum work by that locomotive can be accomplished. As an example of this, a locomotive of certain assumed proportions should do its maximum amount of useful work (and by this useful work we mean the product of drawbar pull by the distance traveled in a unit of time) on a one per cent grade at a speed of eighteen miles per hour, whereas if the capacity of the boiler should be increased one-third (the weight of the engine being assumed to be the same for the sake of comparison), the speed at which its maximum work can be done would be increased to twenty-five miles per hour, at the same time the power exerted by the locomotive would be increased nearly twenty-five per cent. This, of course, leads us back to the proposition which has been forced upon all of us, that we cannot have a boiler too large for a locomotive, provided that the question of weight is not an obstacle.

MR. QUEREAU (by letter): I have read the report with considerable interest and profit. It seems to me worth noting that the statement is made that a proper setting of the lead is very important. I believe this matter does not receive the attention that it should. Though the tests made for the committee are not available for the subject for which they were appointed, it would seem that the subject of high steam pressure is of sufficient importance to warrant the continuance of the subject and committee. I have thought that the results of a road test, made to determine the efficiency and advantages of high steam pressure, might be of interest in connection with the committee report. These tests were made under service conditions, with a dynamometer car, the coal and water being carefully measured, the same engine crew used for all the tests, and the loads as nearly uniform as service conditions would permit. The division over which the tests were made had a number of one per cent grades which fixed the weight of the train hauled. A considerable proportion of the division, about one-half, was comparatively level. The following table gives the results of the tests. A trip was 118 miles. The same engine was used in all these tests, the steam pressure being varied:

| Test No. | No. of Trips. | Av. Steam Pressure. | Av. Dyn. Horse-Power Hrs. per Trip. | Lbs. Water per D. H.-P. hr. | Av. Speed M. P. H. |
|---|---|---|---|---|---|
| 1 | 3 | 165 | 1,669 | 42.1 | 18.4 |
| 2 | 4 | 176 | 1,643 | 43.3 | 19.1 |
| 3 | 4 | 179 | 1,922 | 38.5 | 18.4 |

The above results indicate that there was no economy of steam obtained in Test 2 as compared with Test 1 — that is, that an increase in steam pressure, the load or work done remaining the same, did not produce any apparent economy, but rather the reverse. The explanation of this result seems to me to be that in Test 1 the engine was worked at a somewhat longer cut-off than in Test 2, and that this longer cut-off was nearer the most economical cut-off than that used in Test 2.

A comparison of Tests 1 and 3 shows that an increase of 8.5 per cent in steam pressure, accompanied by an increase of 14 per cent in the work done, gave an economy of 9 per cent in the amount of steam per dynamometer horse-power hour. I am inclined to believe that the economy in the use of a higher steam pressure in this case should be attributed to the fact that the work done was increased in a larger proportion than the pressure. In short, that the higher steam pressure was used at a more economical cut-off than the lower pressure.

The conclusion I would draw from the above results is that for simple engines there would probably be no noticeable economy obtained in the use of steam by increasing steam pressures unless the load should be increased in at least as great a proportion as the increase in power. When the subject is considered from an operating standpoint, which includes the wages of the train and engine crews, there will be a considerable saving in the cost of transportation per ton-mile because of the greater loads which can be handled by reason of the greater power afforded by higher steam pressures within the present clearances. This will probably be the chief economy, and is of considerable importance.

MR. TRACY LYON: Since this report was prepared I received some rather interesting figures on the subject of repair of boilers carrying high pressure. One Master Mechanic writes: "The increase of cost in repairs to boilers of locomotives, carrying pressures of 160 and 180 pounds as compared with those carrying 145

pounds, is principally in removing broken staybolts and work on the flues. The increase in expenses in removing broken staybolts is from 50 to 75 per cent. The life of a set of flues is only about ten months in an engine carrying 160 to 180 pounds of steam, and almost eighteen months in an engine carrying 145 pounds of steam, an increase of about forty-four per cent. We are not sure, however, that this increase in the cost of repairs can be attributed to the increase of pressure alone, as with the higher pressures came the long fire boxes and consequent increase of expansion and contraction in their side sheets. We think that this feature has much to do with the increased number of broken staybolts." Another writes: "We have only one high-pressure engine which has been in service long enough to enable us to form an idea as to the difference, if any, caused by the use of high steam pressure, and have found very little, if any, difference in the repairs to this engine over other low-pressure engines, except in the number of staybolts broken. During the past year our record will show about as follows: In engines with 180 pounds pressure, an average of three broken staybolts per month; in engines with 160 pounds pressure, an average of two broken staybolts per month; and in engines of 145 pounds pressure, an average of one broken staybolt per month."

MR. GAINES: Mr. President, I gathered from the remarks made by Mr. Henderson that the use of high steam pressures resulted in more repairs. I hardly think that is the case if the engine is designed properly for the higher pressures. I wish to say that on the Lehigh Valley we have a class of engines that are carrying 180 pounds of steam, and we have had those engines in service now over two years, and those engines have shown no more cost for removing staybolts or any other repairs than our other engines, and outside of the staybolts I doubt if they have cost as much. I would like also to ask Professor Goss how he figures you can gain in reduced transportation with the increased steam. It seems to me that the majority of our engines are overcylindered now, that is, the power of the cylinder is greater than the adhesion, and if you cut down the gross weight of the engine due to the increased steam pressure, certainly you are going to lose in your net tractive power, if I understand the question as it was put by Professor Goss.

PROFESSOR GOSS: In reference to that, the statement simply meant that if the cylinders could be made smaller for a given power, then there would be less dead weight upon the engines, due to cylinders,

and on that item alone there would be a reduced transportation charge.

MR. MARSHALL: Mr. Chairman, the question of the cost of repairs to locomotives carrying high pressure is one which I do not think anybody can answer very satisfactorily at present — the engines have hardly been in use long enough; but our experience with such high pressure in the past certainly does not point to a very large increase in the cost of repairs. Nor do I see why it should. If the entire structure, boiler and machinery, is designed for the higher pressures, it ought to last under those strains just as well as a lighter and smaller engine designed for lower pressures.

There is another matter which I think enters into the question, and that is this, that with these higher pressures everyone has been improving the machinery necessary to construct the boilers to withstand those pressures. The boilers themselves are better made. As for the question of maintaining staybolts, we recently got some figures on the North-Western road from three classes of engines. One of them was a crown-bar boiler, carrying 150 pounds of steam. The other was a radial stay boiler, with a deep fire box, narrow water space, and carrying 180 pounds of steam. The third class was the largest boiler we have had until recently, carrying 190 pounds of steam, with a shallow fire box on top of the frame. For six months the average number of bolts broken per engine for the crown-bar boiler was seven and a fraction — not for a month, but for six months. The radial stay boiler with the deep fire box had 22.7 bolts broken per engine. On the large engine, carrying the highest pressure we have, and with the longest box and the greatest expansion and contraction, there were one and one-third bolts broken per engine for six months. Further, those particular boilers have been on the road for over three years, and in places where the water was sufficiently bad to have some of their side sheets removed already, and I do not think there is a boiler on the road that has cost so little for maintenance. I think part of this is due to better designing and to the improved machinery that is used today for the construction of boilers. The old boilers were not made as the new ones are.

On the question of long ports raised by Mr. Henderson, we are not following that practice. On our latest passenger engines we have reduced the ports from 20 to 16 inches, using the Allen valve, and we find that under various conditions of cut-off and pressure we can get the same mean effective pressure in the cylinders. And we have a

smaller valve to maintain, with less danger of cutting the seats. The question of capacity *vs.* pressure, it seems to me, is one of the most important points raised by the committee in its report. Mr. Forney some years ago, before the Association, gave as a rule, I believe, after a discussion on the subject of boilers, that the only rule he knew of was to make a boiler as big as possible. We have some large freight engines, 19 by 26, with over 2,300 square feet of heating surface. We recently tested them on a division of the road against an 18-inch 8-wheel engine. These large engines weighed 50 per cent more than the 18-inch engine, and yet they took the trains of the 18-inch engines, and having nearly double the heating surface in the boiler, they showed an actual economy in handling that train over what the 18-inch engine could do. That is due, I believe, to the superior evaporation of the large boiler.

THE PRESIDENT: I would like to know if Mr. Forney has also retired. It would be quite a disappointment to me, if it is not to the rest of the convention, to have it go through without our hearing from him.

MR. FORNEY: Mr. Chairman, before I take part in this discussion, I think it would be proper for me to ask a question as to whether an honorary member is permitted the privilege of talking. I had just a slight suspicion yesterday, when the honor was bestowed upon me of making me an honorary member, that inasmuch as for nearly thirty years past I had been talking to this audience at perhaps greater length than was wise, and certainly at greater length than they had the patience to listen to — the promotion to the position of honorary membership was intended to act as a sort of safety valve to shut me up. [Laughter.] I felt, therefore, a little bit of hesitation this morning in taking part in this discussion, although I was very much interested in the subject. It is one that has been before this Association a great many times, and has been discussed in a great many different aspects, and so far as my own observation and thought have been concerned, it may be summed up in the brief formula or statement that within the limits of weight and space to which you are necessarily confined in a locomotive, you cannot make the boiler too big. D. K. Clark, in his book on railway machinery, a good many years ago, expressed the general proposition that the larger the heating surface on a locomotive boiler, the greater the economy, and the smaller the grate surface, provided you can burn enough fuel, the greater the

economy. Now, while I think these two propositions are quite true, they have sometimes led to a wrong deduction, so far as the grate surface is concerned. People have drawn the conclusion that if a small grate surface is desirable, a small fire box is desirable. I think a question about which there is some uncertainty at the present time is as to how large the grate should be in relation to the heating surface, and how large the fire box should be in relation to the heating surface, and while I think that a reduction of the grate surface will very often result in an economy of fuel, yet at the same time I would think it desirable to maintain a very considerable volume within the fire box, so as to give room for combustion to take place. I can recall what perhaps I have related to this audience before, the experience which was had a great many years ago while I was an apprentice on the Baltimore & Ohio Railroad. Mr. Winans was then building the old camel engines, which, as some of you know, had very large fire boxes, and Mr. Hayes, who was formerly a member of this Association, built some 10-wheel engines with boilers of somewhat similar character, but not having so large a fire box or grate. They had a test on the Baltimore & Ohio Railroad of the working of those engines, and Mr. Hayes took the precaution of covering over a portion of his smaller grate with dead plates, and the result was Mr. Hayes showed very much the best results with the consumption of fuel. The consequence was that Mr. Winans covered over a considerable part of his grate with dead plates, and with an increase in economy. I had very much the same opportunity with Mr. Wooten when he first commenced experiments with burning bituminous coal in some of his large fire boxes. He had engines on the Camden & Atlantic road. I remember going to see him soon after he made the first tests, and suggesting to him that he would get much better results with his large grate with bituminous coal if he would cover up a portion of the grate either with fire brick or dead plates. He followed that suggestion, also with a great increase of economy. I am mentioning these circumstances to indicate that the proportion of grate to the quantity of fuel burned in a locomotive is a matter of very great importance, and a matter about which we have not very accurate information at present.

Before going further, though, I recall some experiments which are reported in an old volume of the Master Mechanics' proceedings—some experiments made in South America by Mr. Martin. He took

a locomotive and experimented by covering the grate with dead plates in front and at the back end and on the sides and in various ways, and he gave in very considerable detail the results of his experiment in that direction. He also found that by a judicious use of dead plate he could increase the economy. I do not know of any direction in which experiment is so much needed at the present time in the performance of locomotives as in this one direction of the proper proportion and relation of the grates to the size of boiler and the amount of heating surface which you have in it, and there is probably no direction in which so much economy can be effected as here with proper and careful experiment. I think it was at the last meeting that the question of combustion chambers came up before this Association, and about a year ago I visited the Chicago, Burlington & Quincy Railroad, and I found they had an engine there of the Columbia type, with a combustion chamber in it, and the result of that was there was considerable difficulty from the breaking of staybolts from that combustion chamber. I have seen in my experience combustion chambers tried in boilers a great many times, and I have also seen that in nearly all cases combustion chambers are abandoned, and I think the reason can be explained in a very simple way. In nearly all combustion chambers which have been made heretofore there is a plate at the front end with the water underneath. Consequently, when that plate is exposed to the fire, bubbles of steam are generated underneath the plate and cannot escape freely, and the consequence is that that plate burns out. My own impression is that it would be possible to make a combustion chamber which would get rid of all these difficulties, and it seems to me quite certain that a very considerable gain would result from a judicious use of such chambers in connection with boilers. The trouble with the Chicago, Burlington & Quincy combustion chamber, of which Mr. Forsyth probably can tell you a great deal more than I can, was that it presented more or less obstacles to the circulation of the water from the barrel of the boiler back to the fire box, and there was trouble with the staybolts, and I believe with the fire box, too. I do not know of any work that could be done by this Association which would be so promising of good results as a careful and judicious series of experiments made with a boiler with reference to the size of the grate and its relation to the heating surface. But my past experience has taught me this general fact, that the larger a locomotive boiler is the better results you can get. This recalls a little anecdote, which I may have perhaps related here before. I am beginning to get old, and I sometimes tell stories

twice or oftener. But when I lived in Chicago a good while ago there was rather an erratic individual who was terribly troubled with dyspepsia, and he was accustomed to announce conclusions and suggestions in a very emphatic way, and one morning at the boarding house breakfast table he was feeling very badly, and he said, "Gentlemen, brains are all very well in their place, but a good, reliable set of bowels is worth all the brains in the country." [Laughter.] Now, it is very much the same with a locomotive — a good reliable boiler is worth all the rest of the machinery you can put on the locomotive.

Mr. David Brown: Mr. President, I have nothing to add to what other speakers have already given, with the exception of a few remarks upon matters that have come under my own observation. As regards the combustion chamber, about the first boiler I ever saw had combustion chambers and they very soon took them out, and it is the same right along now. Whatever combustion chambers I have seen of late are a nuisance anyhow. We had them in the Wooten boiler recently, within the last few years, and we had to take the fire out and send a man in to clean out between the brick wall and the flue. Where engines are in hard service they have got to do that about every three trips. That is a bad feature, and if we can avoid it, it would certainly be a good thing. With that brick wall down, a man can get at his flues through the door and clean them out, and with clean flues it is something like Mr. Forney says — it keeps the bowels in pretty good condition. Regarding the reduction of the grate area, that is a good point to a certain extent. We have very large fire boxes and we have dead plates back and front six inches. On the side we use water bars and intermediate grates. Between the side water bar and the side sheet we block it up, so that we get a space there about 2¼ inches blocked up, and with the water bar altogether it is about 4¼ inches on the sides and 6 inches on the back and front. We like that idea for the reason that it prevents the air from striking the sheets. We make as snug a job as we dare — if possible, make it airtight, to prevent the air from getting in and following along the sheets, for that is where it will stay as long as it can do so. By shutting it off there and making it go through the fire it makes a better combustion.

Professor Hibbard: In connection with Mr. Forney's remarks, I would like to ask Professor Goss a question. I think that he performed some experiments on the Purdue laboratory locomotive to discover the effect of greater combustion of coal per square foot of grate

per hour. That was the purpose of the experiment, and if I remember rightly he obtained that increased combustion per square foot by changing the area of the grate, keeping the power developed by the locomotive constant, and I think that the result of those experiments shows that the locomotive was less economical as the rate of combustion per square foot of grate increased, which would show that in making the grate smaller you gain a less economical boiler. I would like to ask Professor Goss if those conclusions were not legitimately derived from his experiments and would not be an answer to Mr. Forney's remark? I also notice in the report the statement that "It has been suggested that the increased temperature of the fire-box sheets, due to an increased temperature of the steam, might injuriously affect the material." If any member wishes to look up that matter a little more he will find in the files of the *Railroad Gazette* for 1892, under the heading "Effect of Temperature Upon the Tensile Strength and Ductility of Metals," a somewhat elaborate résumé of what has been found experimentally for the past twenty-five or thirty years with respect to the changes in ductility — lessened ductility with increased strength, as you increase the pressure of your steam, but that up to 250 pounds boiler pressure it does not at all dangerously affect steel.

MR. FORSYTH: As a result of the committee's report and also of the discussion, I think perhaps many members would still feel doubtful whether it was the best thing to increase pressure on locomotive boilers or whether they should increase the capacity of the boiler. The committee's report shows very plainly that there is little gain in economy due to increased pressure, but they do not emphasize, I think, the value of the increased capacity of the boilers. For instance, if we increase the pressure from 160 pounds to 200 pounds, the capacity of the engine must be increased directly or nearly twenty-five per cent, that is if the traction and other proportions are proper for that increase. The case cited by Mr. Marshall in the use of a large engine with large heating surface with a small train would show the economy of using a large boiler, but I have no idea that the North-Western Road expects to use that engine with such a small train. They will load it down to its capacity, and when it is so loaded it will not have the economy which is shown with a small train, and I think that is the principal argument for increased pressure on locomotives — the increased capacity which we get as a hauling machine. We are not building locomotives especially to save coal, nor these

large boilers to economize in coal, but we are building large locomotives for hauling machines, and the higher the pressure we get on them the more efficiency they will have as hauling machines. [Applause.]

MR. MARSHALL: Mr. President, I agree wholly with what Mr. Forsyth says. The North-Western Road does not intend to use those engines in the manner indicated in the tests. The question came up, however, as to the economy under those conditions, and it was to determine that that the tests were made. I do believe, however, that when you have a very large heating surface in a boiler in proportion to the cylinder power, that you are going to obtain economy under all conditions as compared with a smaller heating surface, and you are going to have an engine that is always ready for its work. In other words, if you could get along with several hundred feet less of heating surface in summer weather, when it came to zero weather or 20 degrees below, with very heavy storms, that engine is more nearly capable of doing the maximum work for which it was designed than it was with a small boiler. In other words, it has better staying powers. In that direction I believe it pays, if in no other, for the increased heating surface. But with larger heating surface I believe the economy falls off very much less as the engine is forced. After these same tests were completed, we hauled a heavy train over a division that required practically twice the drawbar pull as exerted during the tests, and the evaporation only fell off from 6.4 to about 6.15 pounds of water per pound of coal, nearly doubling the work done by the engine.

MR. SINCLAIR: Mr. President, I feel like challenging Mr. Henderson's statement regarding the length of steam ports. He spoke of an engine of a certain kind with the steam ports 23 inches long and the cylinders 19 inches. I know something of engines of similar size of that sort that were by no means economical engines, and there was very great objection to the size of the valves and the strains put on the valve motion thereby. The company that had those engines built a set of the same class afterward with no other particular change except that the steam ports were made 18 inches long, and the engines with the shorter ports worked with just as much steam economy as those with the longer ports, and the strains on the motion were not found to be nearly as great. I think that the statements about excessive size of steam ports being conducive to economy are mere theories that have not been sustained by practice. The experi-

ments that they have been making with the Schenectady locomotive at Purdue University seem to sustain that point. They find a difficulty in getting up to the point of economy that they had with the previous engines on account of the very large piston clearances. The objection found there will, I believe, apply to all locomotives in ordinary service. The experience of the Chicago & North-Western as mentioned by Mr. Marshall points in the same direction, and I think that those who are responsible for the designs of American locomotives should be very careful about extending to a great extent the size of the steam ports.

MR. HENDERSON: It is possible that Mr. Sinclair and some of the others thought that I was advocating such a great length of ports, whereas I merely stated in my discussion that that was the longest ratio of which I had any cognizance; that the Pennsylvania, as I understand, have one class of engines with 23-inch ports and 19-inch cylinders. I did not take any responsibility for stating whether it was efficient or otherwise. But I did state a decided preference for piston valves by which you can get a great length of port with an absolute balance of the valve. I merely wish to correct that impression in case I was considered to advocate that particular proportion.

MR. MACKENZIE: We had some little experience with long and short ports. We find that by increasing the port three inches we get a great deal more economy in doing the same amount of work. It seems to me the length of the port should be governed by the amount of work you are going to do. If you are going to haul four cars with a 10-inch port, and then undertake to haul four cars with a 19-inch port, you will not find the engine economical. The steam line should be increased in proportion to the work you want to do. I understand the last heavy freight engines designed by the Pennsylvania road have a 23-inch port and a 22-inch cylinder. As I said before, I do not believe there is any question about economy in the long ports with the increased work.

MR. FORSYTH: I do not want to take up much more time, but in my remarks I did not refer to Mr. Henderson's figure as to what point of pressure simple engines could be used to advantage at, and I think he mentioned 200 pounds. It ought to have been, I think, part of our committee work to have shown, if possible, where that figure is between 160 and 200 pounds, where simple engines cease to be economical and where it is the proper thing

to compound. Now, in our experience with compound engines, we have found that with 180 pounds boiler pressure that we can get in freight service an economy of 15 per cent with the same type of engines, so that I might say that we have shown conclusively in our practice that at least 180 pounds is the limit where it pays to compound in freight service.

MR. SINCLAIR: Excuse me; do you mean, Mr. Forsyth, that 180 is the lower limit or the higher limit.

MR. FORSYTH: I say that 180 pounds rather than 200 pounds is the upper limit.

MR. SINCLAIR: For a simple or a compound?

MR. FORSYTH: For a simple engine. I do not know any limit for the compound.

MR. JOHNSON: I have listened with pleasure to the discussion of this subject. But I believe I heartily concur with the committee in what they report in reference to high pressure for locomotives. In my experience as a locomotive plugger of the old type I have found that with a heavy train, cold water and a tired fireman were not very effective. I have in my mind a certain incident that happened on a road on which I was running and had been in service on that road on a locomotive for two years and a half. We got a new superintendent and he happened to be an engineer. Previous to his advent we were going over the road with twenty-two cars as a load, making four trips a week and 185 miles, cut into two sections. His first move was to cut off the loafing point and give us the full run for a day's work although we made the four trips a week. The next was to advance the cars from twenty-two to thirty. The consequence was a great many of our friends laid down on the knobs as we used to call them—could not get anywhere. I was running a 16 by 24 inch Rogers engine at that time, and as a loafer I never was a success and I did not like the idea of laying down on the hill, and as there were no stringent rules against it I just quietly moved the indicator back 25 pounds; and, Mr. Chairman, I need not tell you as a practical man of some years' experience that I did not lay on the hill. The consequence was I was going over the road pulling thirty cars with three cords of wood to the hundred miles while some of my friends who had three times the experience I possessed and were twice as good men on a locomotive, possibly, were using from five and a half to six. Now, I think that is a practical illustration of the fact that higher pressure gives greater efficiency. With reference to combustion

chambers, we have had some experience in that line and we found that part of the boiler making the combustion chamber deteriorated very fast. They were removed and brick arches put in their places. These we found very efficient from the fact that while the engine lay still they absorbed heat which was used at a later point of time in igniting the gases. In reference to the combustion chamber, I note some of my friends talk of blank grates about the fire box. I worked for a gentleman at one time who made some experiments in that line, and we afterward found that by leaving the grates as they were and increasing the nozzles we gained the same efficiency and at the same time made it much lighter on the firemen.

THE PRESIDENT: Gentlemen, I want to suggest that although the subjects are all very interesting — the length of ports, combustion chamber, etc., I do not consider them germane. In other words, I consider the question before the house is the efficiency of higher pressures, and not the methods of obtaining them. If there are any who have any remarks to make in the line of the report I will be very glad to hear from them and would call on them to get on their feet as soon as possible. We are dragging it out considerably, and if this is not responded to I shall ask Professor Goss to close the subject.

PROFESSOR GOSS: Mr. President, a question was asked concerning certain experiments on grate areas. Is it the desire of the house that I answer that, in view of the ruling of the chairman?

THE PRESIDENT: Unless it is requested by the convention, I shall rule that it is not germane to the subject of the report of the committee.

PROFESSOR GOSS: In closing the discussion, I would simply call attention to the fact that the subject is the efficiency of high-pressure steam for locomotives rather than the efficiency of locomotives carrying high-pressure steam, and that statement answers quite a number of criticisms which have been made upon the report. I have nothing more to say, Mr. President.

MR. SINCLAIR: I move that the discussion be closed.

MR. POMEROY: From something that has been said I am led to think that a great deal of information can be gained and much practical benefit derived by a further continuance of these experiments, as it is stated that a good deal of the work was hampered from the fact of mechanical changes which could be remedied in the future, and I

would move that the committee be continued to carry out to fuller completion the results of the work laid before them. (Seconded.)

THE PRESIDENT: Gentlemen, in behalf of my successor I will request that that motion be made so that it will take in not only the efficiency of higher pressures, but the best methods of obtaining the steam and its use, in other words, the proper proportion of grate to heating surface, and the results of such experiments in the use of these higher pressures under different conditions, as it is very unpleasant to have to call members to order when it really robs the subject of its interest to confine them to as narrow a limit as this title calls for. Will you please make your motion so that it will cover that. I ask it not for myself, but for my successor.

MR. POMEROY: I am only too glad to do so, Mr. President.

MR. MACKENZIE: I second the motion.

MR. MARSHALL: Before you put that I want to say a word. It seems to me you are putting a great deal of work on that committee. It would be a big task if they should find out for us the economy of high steam pressures, and possibly include in that the question of boiler capacity, but taking in the question of combustion chambers and grates, etc., is adding a very large task, and they will not get through with it for several years.

THE PRESIDENT: I don't think they ought to. I wish to say that it is in order to broaden their field, simply to relieve them from restrictions, that I am asking it, not only for the sake of the committee but for the Association. There is not any motion except to continue the committee, because there has been none formulated. Is the mover willing to let it go just as he made the motion, that the committee be continued?

MR. POMEROY: Question.

THE PRESIDENT: The motion is that this committee be continued on the same lines as the past.

MR. LYON: I would like to offer an amendment to that, that the committee be discharged and the matter be referred to the Committee on Subjects.

MR. SINCLAIR: I second that.

THE PRESIDENT: You have heard the amendment. What is your pleasure in regard to that? As many as are in favor of the amendment signify by saying "aye"— contrary minds, "no."

The amendment was carried, and, on motion of Mr. Sinclair, the discussion was closed.

THE PRESIDENT: I would now like to hear from Mr. Sague on the third subject — the report of the Committee on Cylinder Fastenings.

MR. SAGUE: The report I have is signed by Mr. Sanderson and Mr. Chapman on behalf of the committee. The report being in the hands of the members, it is probably not necessary to read it entirely.

Mr. Sague gave an abstract of the following report:

## REPORT OF COMMITTEE ON BEST FORM OF FASTENING FOR LOCOMOTIVE CYLINDERS.

*To the President and Members of the*
*American Railway Master Mechanics' Association:*

The instructions to your committee contained in the two words "Cylinder Fastenings," are not very clearly defined, and might consistently be considered as embracing the entire designing of locomotive frames, cylinders, and parts of the boiler, or might be laconically summed up in the three words, "Bolts and Keys."

It is believed, however, that a middle course between the extremes of prolixity and brevity will be the most useful, and the following report confines itself to the discussion of the points bearing on "Cylinder Fastenings" for cylinders and frames of the types familiar to us all.

The physician of the past knew little of the causes for sickness; he relieved the headache, soothed the nausea, eased the inflammation, and tried to make the patient comfortable, generally accomplishing a good deal in this direction to the satisfaction of all parties. The patient might die just the same in the end, but he had the relief from excessive pain and distress. The modern physician regards the symptoms only as of importance as indicating the true cause of the disease, and strikes at the root of the evil.

Simply to review the results reported by different railroads, without making an effort to understand the underlying causes, would not advance the art, but would leave us in hopeless confusion because the results reported by different parties are absolutely opposite for the same designs — what one man has complete success with, his neighbor has found to be an utter failure.

A brief reference to the strains to which the cylinders and attached parts of a heavy locomotive are subjected and to locomotive design in general, will, it is thought, help us to a better understanding of the subject. In the sense that an electric machine is designed to convert some newly discovered electric law to man's use; as a Brooklyn or Forth bridge is designed to fulfill a prescribed purpose under an entirely new set of conditions; or as a skilled mechanical engineer, with a new purpose of process to accomplish, designs a new machine or apparatus with full knowledge of the physical properties of the materials he is to use and the difficulties to be overcome, the modern locomotive can lay no claim to design. It has developed

or "growed" like Topsy, by a process of enlargement of cylinder and boiler power, to be followed up by a strengthening of parts that were found to be too light *after* they failed. If a skilled mechanical designer, who had never seen a locomotive or a drawing of one, were set down to design a heavy locomotive, all the conditions and leading dimensions, such as diameter, stroke, and spread of cylinders, size and spacing of wheels, type and size of boiler, etc., being prescribed, it is probable that the resulting designs would not have forged frames, cylinder saddles and many other traditions, along the narrow lines of which the modern locomotive has developed.

The economic desire to perpetuate standard patterns and to embody as many as possible of the previous standard parts in any new larger class of locomotive, has spoiled many an otherwise good engine. Engine frames of the bar-forged type were made 4 inches wide for 14 by 22 inch eight-wheelers in the early '60s, and are still made 4 inches wide, whether the fire-boxes are between the frames or on top, for cylinders 35 by 32 inches. In the old days of light weights and small powers, light rails, no ballast and rough, crooked elementary railroads, the flexible engine frame was a necessity, and being made of long, light bars, the bending was seldom concentrated at points, so that fractures were not too frequent and welding was an easy matter. But with the increase of cylinder power from, say, 17,500 pounds to 76,000 pounds, of train shocks from those produced by trains of 250 to 300 tons up to 1,000 tons and over, light frames are out of the question. The heavier the bar that has to be bent the fewer bendings it will stand, because while the strain on the entire bar may be below the elastic limit as usually understood, the fibers farthest from the neutral axis may be strained beyond that limit, and with recurrences will commence a growing fracture, microscopic at first, but ending in the destruction of the piece — where there is flexure will follow fracture.

I therefore believe that for modern weights and powers of locomotives, if the frames, cylinders and boilers are to stay together without a loose bolt key or crack (barring wrecks, of course) from the time the engine leaves the builders until it goes on the scrap pile, absolute rigidity and unity is imperatively necessary. The boiler, cylinders and frames should, under all conditions, be absolutely inflexible and immovable relative to one another; all necessary limberness of the machine as a whole must be provided for by the springs and system of equalization.

The strains that the "Cylinder Fastenings" have to resist are:

First: The direct alternating thrust of the steam in the cylinders at the frames up to, say, 38 tons, reversing itself several hundred times a minute and increased to unknown amounts by shocks due to water in the cylinders. For instance, to knock out a 22-inch cylinder head would require something like 125 tons pressure suddenly applied, and the cylinder fastenings must not be phased by this.

Second: The direct forward and backward surging of the boiler — as the back end of the boiler must be on slides or links to allow for expansion and contraction, the cylinder saddles alone must resist the tendency of the boiler to move lengthwise, due to train and coupling shocks, collisions, etc. What the shearing strains on the saddle bolts and cracking strains on the saddles are when the momentum of one of our huge modern boilers is suddenly destroyed is not easy to conjecture.

Third: Forward and backward sliding of the two saddles on one another, due to the cranks being at right angles and the impulses in the cylinders not occurring

simultaneously. This is greatest at the bottom at the level of the centers of the cylinders and least at the top of the saddle.

Fourth: Wrenching strains due to the engine curving, where one side of the engine must be held back by the other, and the adhesion of the wheels on the inner rail constantly broken. As there is no diagonal bracing to keep the frames from moving lengthwise separately from one another, this purpose must be accomplished by the strength of the cylinder saddle. Similarly, if the engine slips and happens to catch on one side first, very severe wrenching strains are produced in the saddles.

Fifth: The forward thrust on the cylinder and smoke-box bolts, due to the expansion of the boiler and resistance sometimes offered by the back boiler fastenings being defective or jammed.

Sixth: Wrenching of the saddle, due to the back end of the boiler swinging laterally on the frames; this is a very frequent defect with long boilers having heavy fire boxes, and is especially noticeable on engines having poor back boiler fastenings when they are slipping.

As to this last — sixth — cause is attributable most of the trouble with looseness between the smoke boxes and saddles, we will refer to this matter first. If we wish to steady a pendulum, hammer or axe from moving, we fasten it by the weight or head, we do not leave the heavy end insecure and then attempt to prevent it moving by gripping the end of the handle extra tight. Similarly, the place to remedy the looseness of the cylinder saddle and smoke-box joint is at the back end of the boiler.

In reviewing the information gathered on this head, we see that, considering what has been said above, the best designs for securing the back ends of boilers to frames to prevent wiggling would be such that:

The weight of the boiler should be carried on two, or preferably four, long slides up to 12 inches in length and over.

The weight of the boiler should be transmitted directly from the mud ring to the top of the frame through substantial chafing pieces on the frames, which can be easily renewed if worn; the mud ring being machined where it rests on these as at Figs. 1, 3 and 4.

The weight of the boiler should not be carried by pads on the sides, depending on studs or rivets, as at Fig. 2.

The boiler should be held down firmly to place by four side clamps, as at Fig. 1 or Fig. 3, which are not depended on to hold the boiler laterally.

In addition to the lateral security afforded by bearing pieces such as are shown in Figs. 3 and 4, the boiler should be held to place laterally by strong bracing placed crosswise under the boiler at the front of the fire box, and, where practicable, across the back of the fire box where the material can be disposed in the best direction to resist lateral movement, and tie both frames together, as indicated in Figs. 5, 6 and 7.

The boiler should also have at least one expansion brace, as at Fig. 8, to help keep the boiler and frames from the slightest relative movement or springing; but to be of lasting service this expansion brace must be made with double heavy angles at the boiler, close riveted to the shell (2½ to 3 inches spacing, ¾-inch rivets), and similarly close riveted in reamed holes between the angles and the expansion plate, and firmly secured to the cross brace, which must be well lipped over and bolted to both frames,

Fig. 8. By using a broad steel casting for the cross brace greater stiffness is obtained and it helps to brace the frames. To use a single T or angle iron at the boiler with a few bolts to hold the plate to this is a dead waste of material.

Carrying the back end of the boiler on links and pins is bound to lead to trouble sooner or later. The bearing surfaces cannot be large; they will be hot all the time, and as they cannot be successfully lubricated, must be made a loose fit to start with or they seize and wring off. When thus made a loose fit they permit the initial looseness which, with the constant jarring and pounding of the weight of the boiler on these two or four pins, soon produces considerable slack which will break off the pins eventually and in the meantime allow the back end of the boiler to waggle on the frames, thus wrenching the cylinder and smoke-box fastening severely. The smoke boxes of our heavy engines have been too often made as if they had no other duty to perform than to hold smoke, and because they have no steam pressure to retain are made of flimsy sheet steel, whereas the smoke box is really a part of the foundation of the whole machine.

How can we expect to hold the heavy boiler firmly to the cylinder saddles and frames without any buckling and giving when the smoke box is only made of 5-16 or 3/8 metal? The smoke box should be made of as heavy plate as the boiler itself, and there should be a strong attachment to the boiler by means of a wide 1-inch thick ring, as shown at Fig. 9, as well as a second ring at the front of the saddle and bars 8 to 10 inches wide, as shown in Fig. 9, all closely riveted to the smoke box. This gives all the bolts through the saddle and smoke box the same length and a good 1 3/4 inches of metal for reaming to a good fit.

One member very pithily writes: "We find that too many bolts *cannot* be used in securing the saddles to the smoke boxes"; but it is believed that if the back ends of the boilers are well secured as recommended previously, fastening the saddles to the smoke boxes with a double row of 1 1/4 or 1 3/8 inch bolts all around, spaced 4 1/2 inches or not over 5 inches pitch, having the flanges of the saddles strengthened by ribs all about as shown on Fig. 9, will form, with honest workmanship, as secure a fastening as is needed, but not more than is really essential for heavy locomotives. All the bolts holding the saddle to the smoke box should be on the outside of the saddle in the flange, with heads inside and nuts underneath where they can be seen. Bolts inside the saddle put up from underneath which cannot be made a driving fit, and the nuts for which must be inside the smoke box, are believed to be not worth the trouble of putting in. They cannot be properly fitted or inspected afterwards for looseness; the nuts are subject to the heat, and being located near the center of the saddle they have not the same leverage to hold the saddle steady as they would have if placed on the outside.

Incidentally it may be interesting to call attention to the necessity of using bolts of large size and hard, tough metal; experience having shown that after careful reaming and fitting the fit can be ruined and the bolt left loose in the hole after drawing up with a long wrench, by the stretch of the bolt if made of too small diameter or of too soft material.

Considering next the fastening of the two cylinders together, it must be remembered that the force tending to separate or slide on one another is exerted at the bottom on the plane of the centers of the two cylinders and not at the top. To resist this to the best advantage, the strength of the fastening should be at the bottom and

not at the top, and yet we find arrangements such as are shown at Fig. 10, where the bolts are very poorly disposed, and Fig. 11, where the bolts are better placed; but the same amount of metal in short bolts at the bottom of the saddles would have been much more effective, as indicated at Figs. 12, 13 and 14. The continual trouble from loose and cracked cylinders has led to the very common use of cross-frame braces lipped over the frame bars and shrunk on, as indicated at Fig. 15, both front and back of cylinders on both upper and lower frame bars. This is certainly a more reasonable disposition of the metal to effect the intended purpose than the use of 2-inch bolts placed as at Fig. 10 or Fig. 11. When such braces or clamps are used, it is necessary that the frames should have a good inside bearing against the cylinder saddles so the clamps will pull the frame against the casting (see Fig. 15) and not pull against or shear the frame bolts.

But it is believed that if the saddles are correctly designed in other respects and the frames properly proportioned and connected, such clamps will not be found necessary, but the saddles should be bolted together as shown at Figs. 12, 13 or 14, and it is a good plan to fit one or perhaps two good keys in this bottom horizontal joint to relieve the bolts from shearing strains. These keys can be chipped off flush at the bottom and prevented from working down by placing them over the truck center or equalizer fulcrum casting.

Before discussing the fastening of the cylinders to the frames, there are some questions strongly bearing on this which may be profitably considered. Referring to the strains on the cylinders and saddles previously described in the six numbered paragraphs, it will be seen that there are some that must be wholly absorbed by the strength of the saddle. The plain bottomless box form of saddle with cored steam and exhaust passages looks massive enough, but the metal is disposed in the weakest possible form to resist the strains referred to. Above all, there is need of plenty of metal to act as a horizontal bed plate at or near the plane of the center lines of the cylinders. We find efforts to remedy this lack by numerous clamps shrunk on in front and back of the cylinders to strain them tighter together (Fig. 15), but here again the metal is applied at right angles to the direction of the strains. We also find horizontal plates applied front and back of the cylinders lipped, for the frames; in some instances these being bolted to flanges cast on the saddles for the purpose (Fig. 16), and again others have been driven to the use of long cast-iron bumper deck plates, filling the entire space from the saddle to the front bumpers. All these are remedies for an originally bad design. There seems to be some tradition, that no one has yet broken away from, that the saddles must not be any longer than the cylinders. For instance, for a 14 by 24 inch cylinder the saddle would be about 28 inches long; for a 33 by 24 inch cylinder, the saddle would still be 28 inches long. The length of the saddle is its strength to a large extent.

Is there any reason why the saddle should not be made 6 feet long between the frames and thus furnish horizontal longitudinal stiffness which would keep the cylinders and frames square? This would do away with the necessity for clamps, plates and extra castings (Fig. 17). But there are still formidable strains on the saddles that require additional strength in the upper part, and it is certainly good practice to rib the saddle vertically on both sides, front and back, and also use horizontal ribs as indicated in Fig. 18.

To revert incidentally to a detail that is of real importance, attention is called to

the necessity of making all keys and key ways, as well as all slots and angles where frame bars are bolted to cylinders, with fillets in the corners as indicated at Figs. 19 and 20. Sharp corners are always weak spots and prove themselves too often starting points for cracks.

Reverting to the argument previously made in favor of rigidity and against elasticity in the construction of the frames and attachment to the cylinders, it will be admitted that the recommendations of several prominent members to the effect that double-bar frames should be always used for heavy locomotives even of the eight and ten wheeled types, is in the right direction and we recommend this as good practice.

Where single-bar frames for special reasons must be used, they should be made of proportionately greater strength as indicated at Fig. 21. It seems absurd to continue using 4 by 4½ single-bar frames for all sizes and powers of locomotives. In passing, we wish to call attention to a method of securing frames to cylinders which is illustrated at Fig. 22. This plan has been used with reported success for many years on several well-known railroads. It is a departure from the usual practice in that there are no bolts securing the cylinders to the frames, which are set into troughs in the saddles, held there by caps and are secured lengthways by stout keys front and back of the cylinders.

A further departure from usual practices is illustrated in Fig. 23, where the bolts holding the cylinder to the frames are put in from the bore of the cylinder. This was due to the large diameter of the cylinders and necessity of keeping the cylinder centers as close together as possible. As long as these bolts do not break or come loose, the arrangement is a simple method for overcoming the difficulty; but if the head of one of them should work back and foul the piston, it would likely cause a bad breakdown.

A better plan for accomplishing the same purpose is shown at Fig. 24 which works out very nicely in practice.

The details of the fastening of the frame bars to the cylinders must depend on the height and spread of the cylinders, height of center of axles, diameter of truck wheels and necessary clearances, so that all that can be done without knowing these limiting conditions is to present a number of sketches showing various designs for attachment of double-bar frames to cylinders, see Figs. 25, 26, 27, 28, 29.

There are, however, some points that are common to all that should be mentioned. Long vertical bolts through both top and bottom frames and cylinders should be avoided. They are expensive to turn, the reamers are expensive and most difficult to make, the castings are troublesome to core and the stretch under equal tightening is not the same as for the short bolts.

Tap bolts might just as well be left out, to start with, for all the good they ever do.

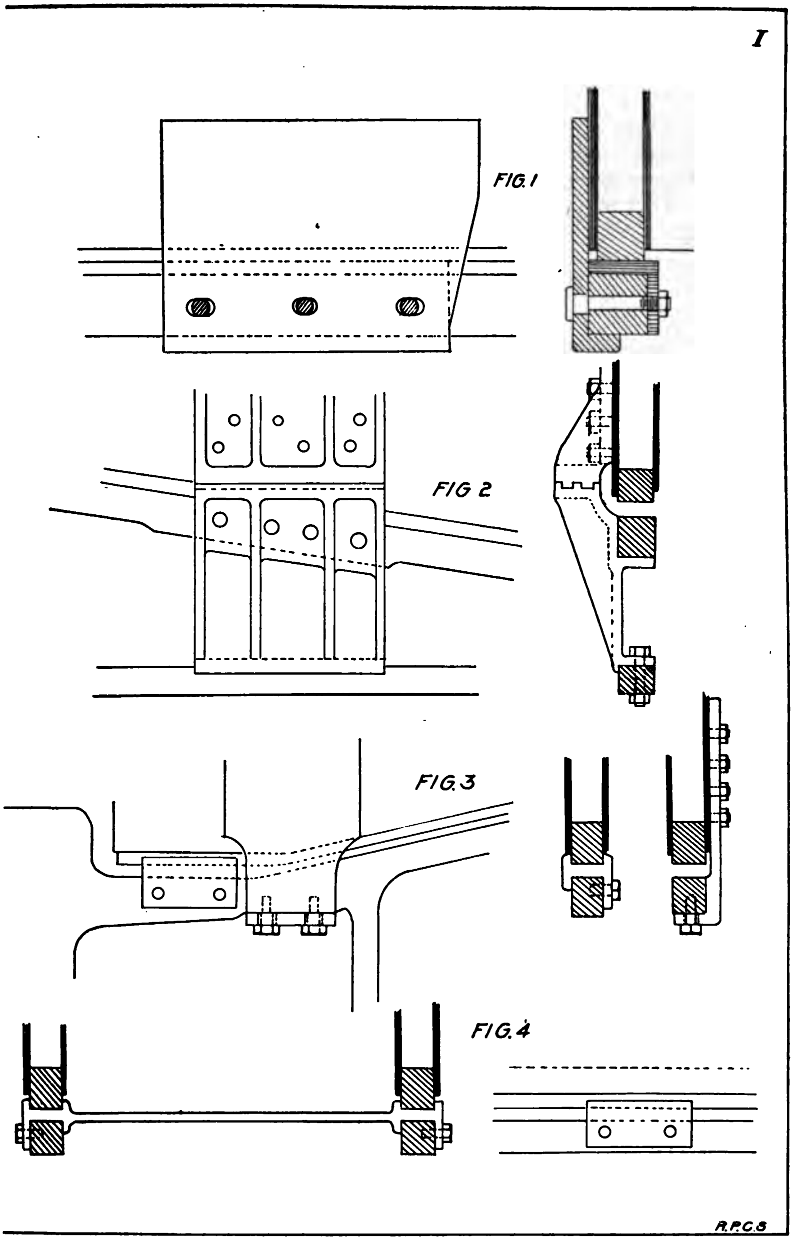
Keys between the cylinders and frames should be made large enough and very carefully fitted to a perfect bearing before final driving.

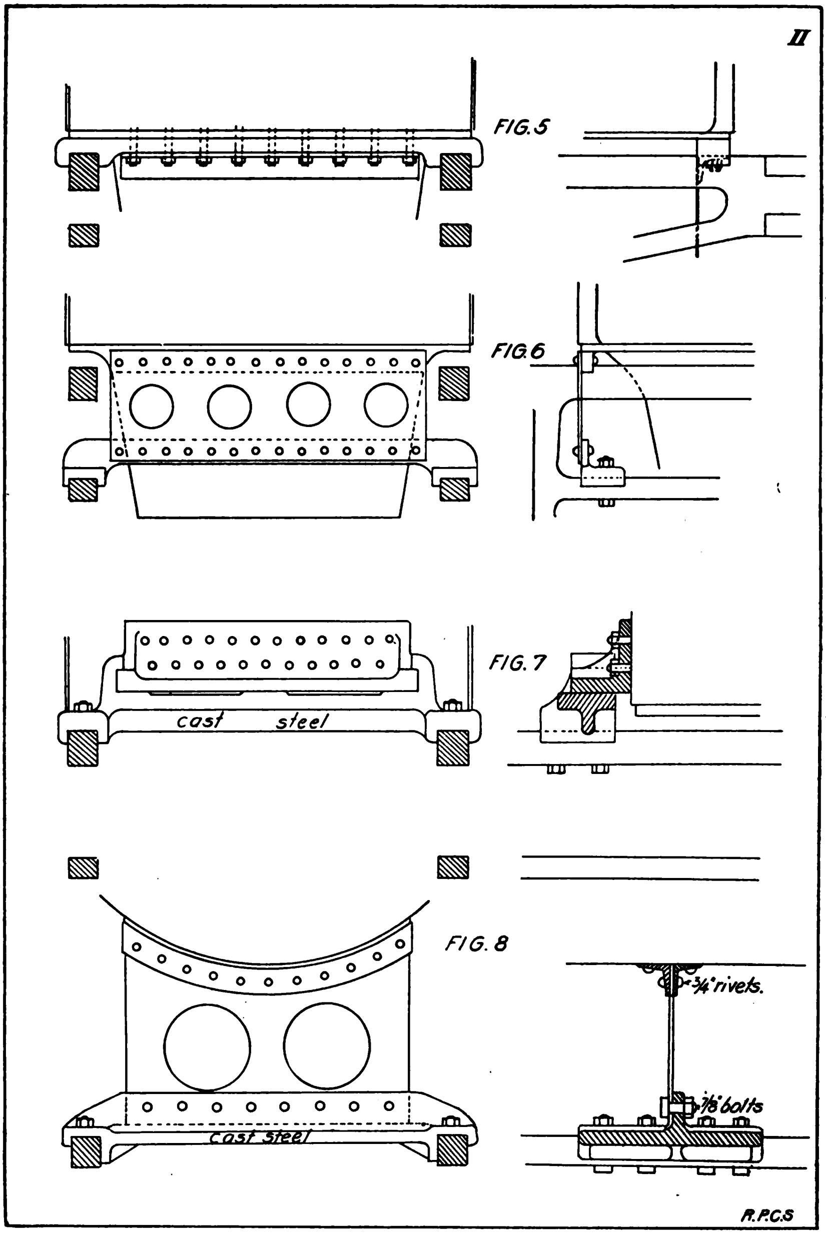
Both top and bottom bars should butt solid up against the back of the cylinders, being machined to a gauge, and the cylinders faced off accurately; this insures perfect squareness, keys being used in front to draw the frames up solid to the cylinders before the bolt holes are reamed. Continued trouble with loose splice joints in the frames has led to the use of blocking castings between the top and bottom bars of the frames behind the cylinders, and there is no doubt this is very good practice.

This same trouble has led some to do away with one splice joint, and carry the main frame forward to the front edge of the cylinder; but if this is done the top frame, which is the main strength of the frame, should be carried forward over the cylinder, giving a solid forging from the front of the saddle to the back tail bar.

Finally it may be predicted that a few years will see the very general use of cast steel for locomotive frames, and as the possibilities with this metal are great, it may be that we will find both frames and cylinder saddles all cast in one piece with the two cylinders and the upper part of the saddle made of cast iron and bolted on.

R. P. C. SANDERSON,
T. L. CHAPMAN,
*Of the Committee.*


I
FIG. 1
FIG 2
FIG. 3
FIG. 4
R.P.C.S


II
FIG. 5
FIG. 6
FIG. 7
cast steel
FIG. 8
3/4" rivets.
7/8" bolts
cast steel
R.P.C.S

III

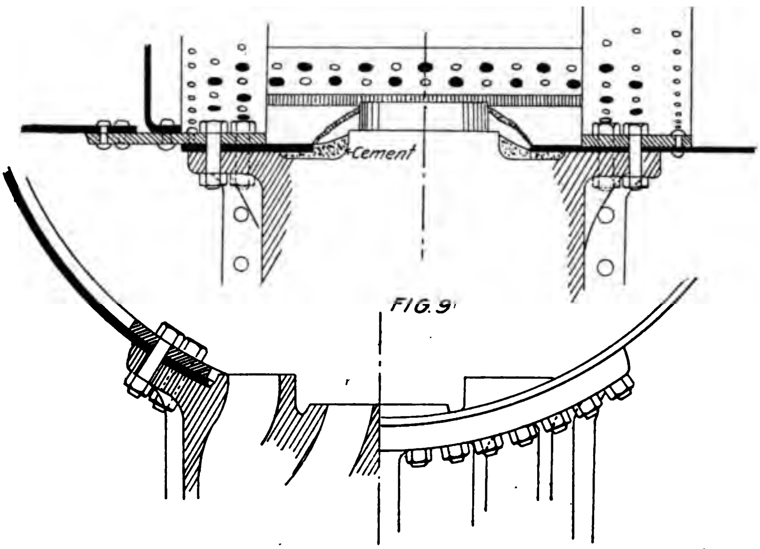



FIG. 9

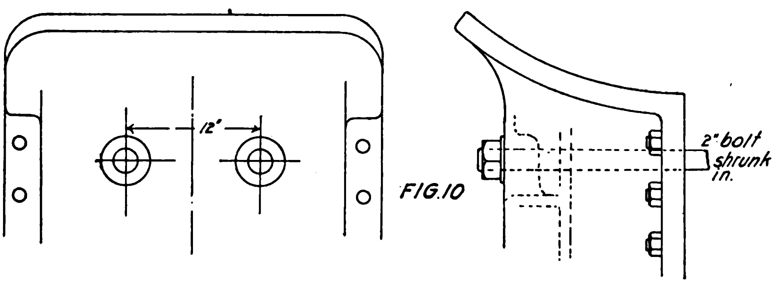



FIG. 10

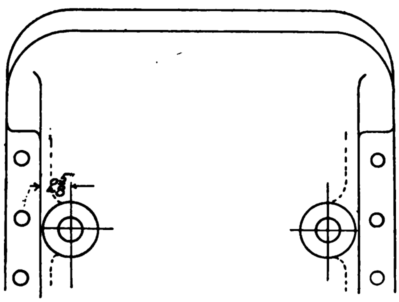
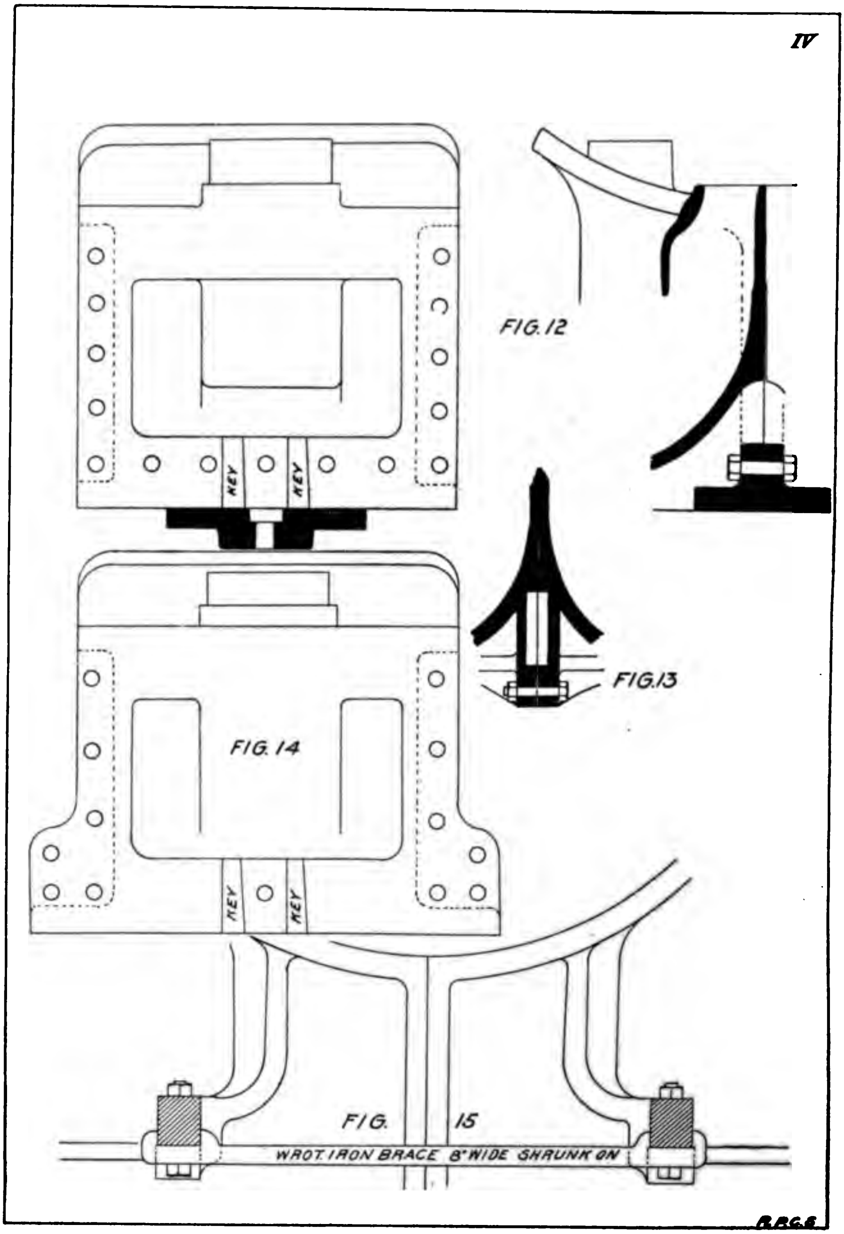
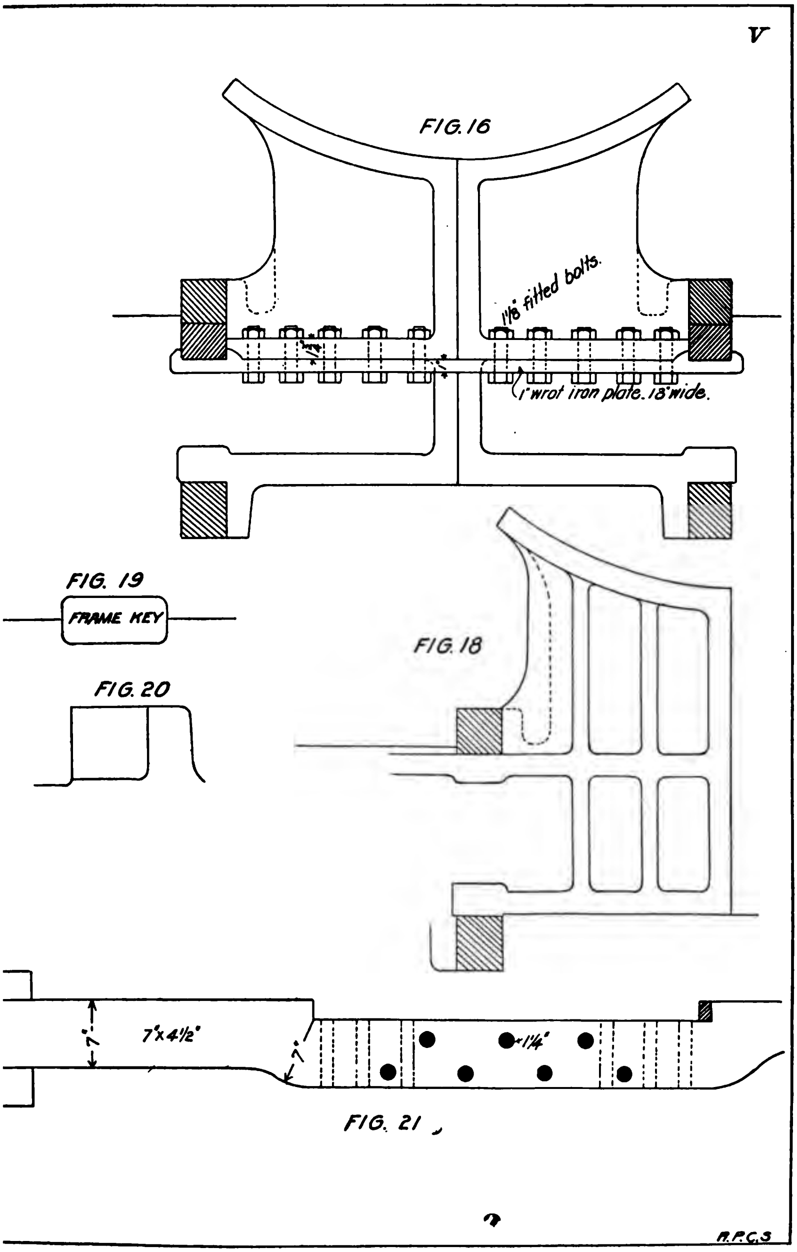


FIG. 11

R.P.C.S.


IV
FIG. 12
KEY
KEY
FIG. 13
FIG. 14
KEY
KEY
FIG. 15
WROT. IRON BRACE 8" WIDE SHRUNK ON
B.P.C.S.


V
FIG. 16
1⅛" fitted bolts.
1" wrot iron plate. 18" wide.
FIG. 19
FRAME KEY
FIG. 20
FIG. 18
7"
7"x4½"
7"
1¼"
FIG. 21
R.P.C.3

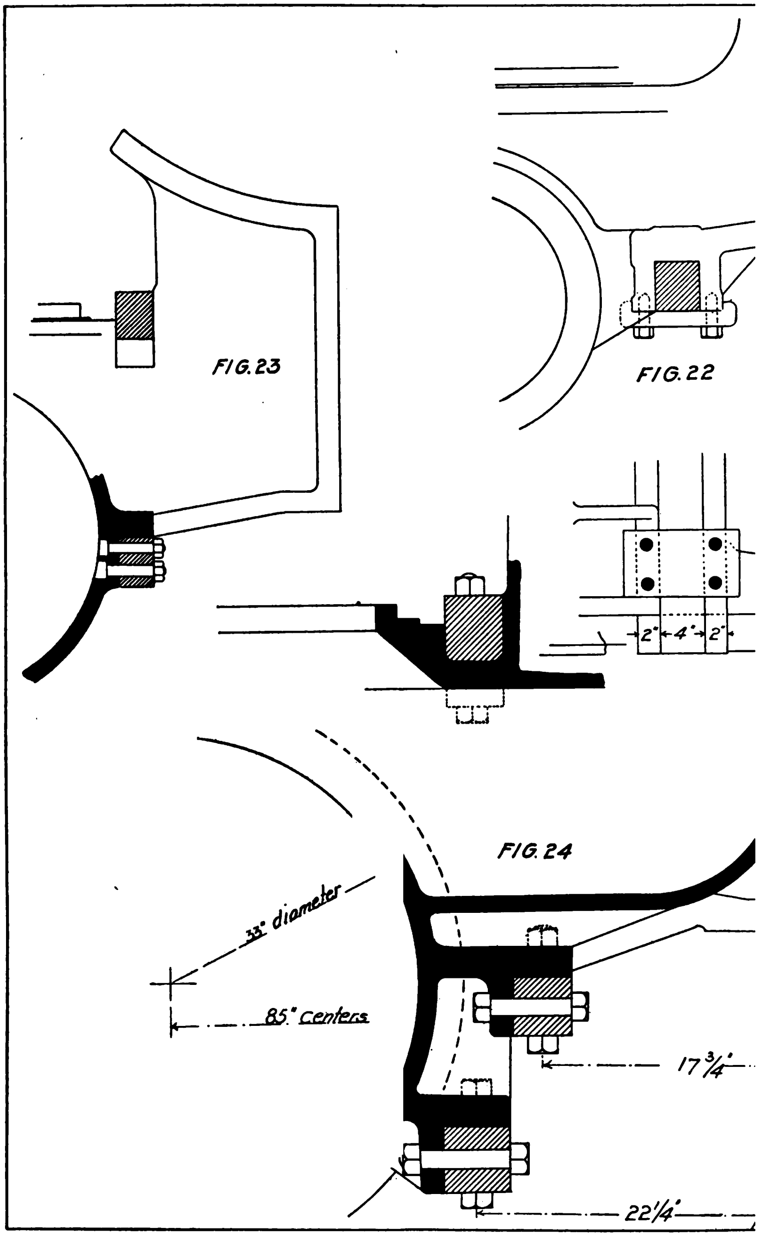
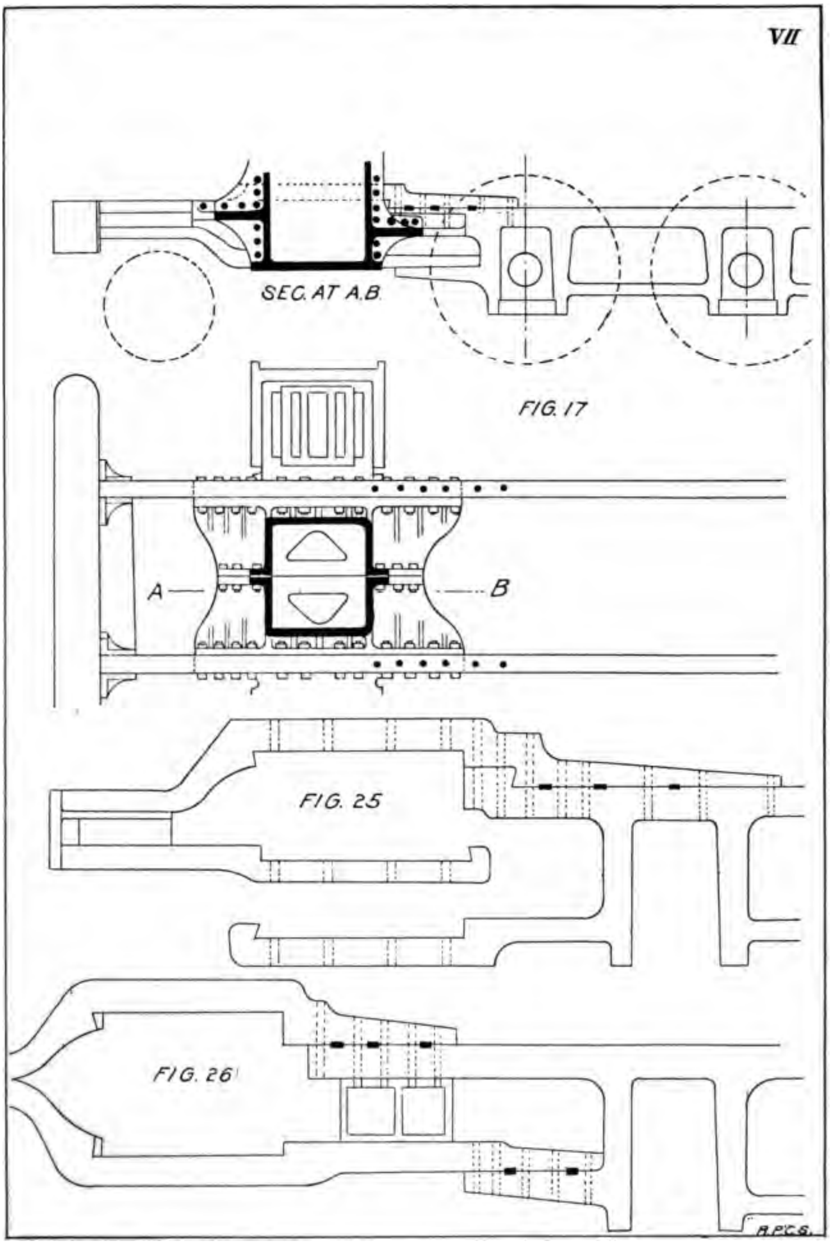


FIG. 23
FIG. 22
2"
4"
2"
FIG. 24
33" diameter
85" centers
17 3/4"
22 1/4"


VII
SEC. AT A.B.
FIG. 17
A
B
FIG. 25
FIG. 26
R.P.C.S.

VIII

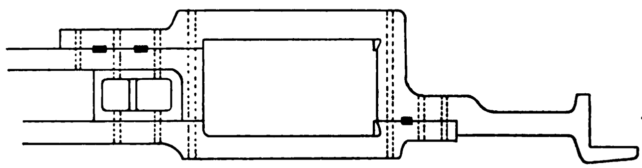


FIG. 27

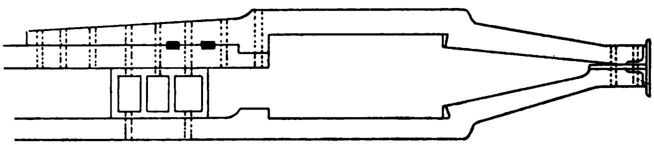


FIG. 28

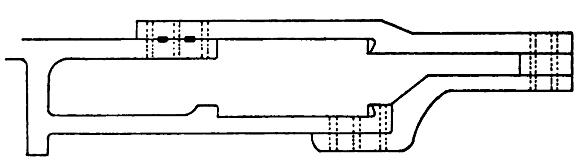


FIG. 29

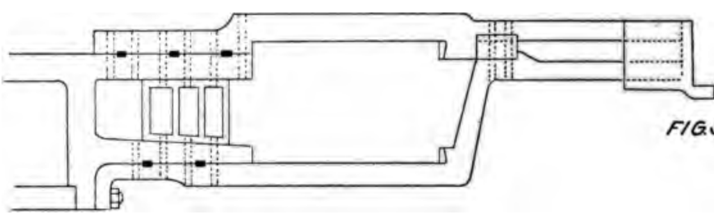


FIG. 30

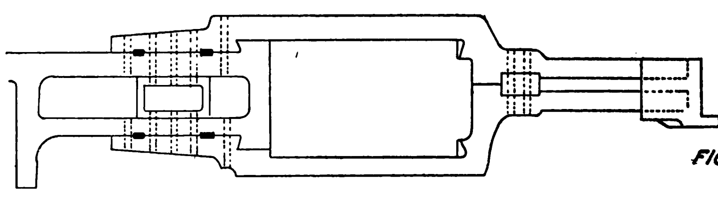


FIG. 31

B.P.C.S.

Mr. Sague: The writer has prepared a supplemental report on this subject. It is not intended as a criticism of Mr. Sanderson's and Mr. Chapman's report in any detail, but simply as affording some additional information.

Mr. Sague then read the following supplemental report:

## SUPPLEMENTAL REPORT ON BEST FORM OF FASTENING FOR LOCOMOTIVE CYLINDERS.

It has been impossible to arrange for a meeting of the Committee on Cylinder Fastenings, and the members therefore have been unable to discuss the subject thoroughly enough to agree fully upon all details. Owing to business engagements, the chairman of the committee was unable to assist in the final preparation of the report and the work was therefore kindly assumed by Mr. Sanderson, although the time left at his disposal was very limited. The following is submitted by the writer as an additional discussion of the question, and to cover some of the items of information which have come to hand since the main report was completed.

The strains on cylinder fastenings, as well as upon other parts of locomotives, have been much increased within the last few years by the notable rise in boiler pressures, which has resulted in a more marked increase in locomotive power than is indicated by comparison of cylinder sizes only. Thus many recent designs of locomotives have 20 by 26 inch cylinders with 200 pounds boiler pressure, or the equivalent of a 23 by 26 inch cylinder with 150 pounds of steam. Modern systems of tonnage rating have also added to strains imposed upon locomotives, making it certain that they will exert their full power more constantly than ever before.

A decided limit, however, is imposed upon the weight of material to be used in cylinders and frames by the demand for high boiler power, and it is very common for builders to have specifications submitted to them calling for greater boiler capacity than can be obtained within the permitted limits of weight, after all possible has been done to lighten other parts. It will be admitted that in order to obtain the best road locomotive, either passenger or freight, the boiler must be made as large as possible, and with this in view the weight of all other parts must be kept as low as good design will permit, assuming reasonably good handling and attention to running repairs, and this condition should be kept carefully in mind in considering the design of cylinders, frames and cylinder fastenings.

The principal strains to which cylinder fastenings are subjected are thoroughly discussed in the committee's report. The effect of these strains on cylinder fastenings, however, are believed to be greatly modified by the use or absence of a foot plate. A foot plate well bolted and keyed holds the frames rigidly in line with each other lengthwise and thus reduces greatly the racking strains upon the cylinders due to the action of the steam. Consolidation and other types of locomotives which have no foot plate, therefore, require exceptional strength in the cylinder fastenings, unless the equivalent of a foot plate is provided. This point is illustrated by an abstract of a letter from Mr. Harvey Middleton, general superintendent of motive power of the B. & O. R. R., referring to locomotives not provided with foot plates: "To prevent breakage of cylinders and frames we further strengthen these engines by using a cast-iron plate ahead of the cylinders, performing the same office in keep-

ing the frames square and preventing racking of the cylinders as the foot plate in the American type of locomotive. We are using this cast-iron deck plate on all of our locomotives which have not the foot plate at the rear of the fire box. It fills the space between the front of cylinder and back of bumper. This plate is 2 feet 7½ inches long. In addition, a cast-iron frame tie two feet long is used to further assist in holding the frames square." Upon this point Mr. Vauclain, of the Baldwin Locomotive Works, writes: "I am inclined to think that on extra large engines the cast-iron deck plate in front of cylinders is a good thing in the absence of a foot plate, but better still, add the foot plate to be done with it."

In recommending designs of cylinder fastenings distinction should be made between passenger and freight locomotives, even where the cylinder power is the same. Passenger locomotives exert their full tractive power only at starting and the cylinder fastenings are not exposed to as severe continuous strains as those of freight engines. Passenger locomotives, as a rule, also receive better care. Large boiler power is of such supreme importance in passenger locomotives that the weight of all other parts must be reduced as much as possible. These considerations, it is believed, justify the use of lighter cylinder fastenings than would be good practice for freight. This is especially true for eight-wheel passenger locomotives whose truck and driving wheel weights are apt to be close to the track limits.

Referring to the connection of cylinders to boiler, the replies to the committee's circular indicate but little trouble with this fastening. Several recommend double bolting either front or back or on the side flanges. The largest bolts shown on any design submitted are 1¼ inches, and a great majority of satisfactory fastenings for heavy locomotives are made with 1⅛ inch bolts spaced about five inches from center to center. Double bolting front and back or on the sides, is extensively used on heavy locomotives, and in a few cases cylinders are double bolted all around. Double bolting front and back has the advantage of lengthening the cylinder fit on the smoke arch and enables the maximum number of bolts to be placed through the smoke-box rings, but for equal weight of metal in the flanges the double side bolting enables more bolts to be used. The Erie railroad reports that it has not been necessary on their locomotives to double bolt any part of the cylinder saddle to the smoke box. Saddles should be carefully fitted to smoke boxes and there should be a good bearing around each bolt so that the full shearing strength may be secured. All bolts in cylinder fastenings should, where possible, be taper to secure good fits. Smoke-box holes should be drilled in place in either the saddle or sheet, and the reaming should be preferably done by power, thus making it easy to get good work.

Regarding the connection of cylinders to frames and the design of frames at the cylinders, practice varies greatly, and it is difficult to lay down any rules which will be of general value; especially is this true regarding the choice between single and double-bar front frames. Double front frames certainly give a more secure cylinder fastening than can be obtained with single rail frames. They make an especially good design for consolidation, mogul and other locomotives in which the drivers are close to the cylinders, and are being widely adopted for heavy ten and twelve wheel locomotives. Considering the strength of the frames only, the design of double front frames involves the use of more weight for equal strength than with single, and this is an important reason for the continued use of single front frames on so many recent eight-wheel passenger locomotives. For this type of locomotive the great

length of single front rail permits some flexibility, and there is less liability of the strains being concentrated at a breaking point than if the rails were short. With the single front rail bolted on a line with the centers of the cylinders, the strains due to the steam pressure are taken directly. With double front frames these strains are exerted mostly upon the bottom rail, as this rail is necessarily much nearer to the center of the cylinder than the upper one. The bottom rail, therefore, requires nearly as much section as if a single rail only were used. The breakages of upper rails, however, show that important strains are transmitted through them, and these are probably quite complex. Very great strains are brought on the upper rail by the expansion of the boiler, especially when the expansion pads are binding. Any yielding or springing of the bottom rail will also throw disproportionate strains on the upper one. The experience of members indicates that to avoid trouble with double front rails it is necessary to design them so as to be as free from bending strains as possible, and to connect them so that they will resist the strains almost as if made of one piece; otherwise the rails may yield and break in sections. This can perhaps be illustrated by reference to drawing No. 1, which shows the design of front frames reported by one of the members as used on mogul freight locomotives in heavy service. Careful inspection of these front frames showed them to be working slightly at points marked "A." This in some cases has caused breakages at "B" or "C." The indications point to bending strains localized where the working and breakage are noticed, and it is also believed that this working was largely caused by the sticking of the expansion pads on the sides and back of fire box. To resist these strains better, filling blocks, similar to that shown on drawing No. 2, are put in and are found to meet the difficulties successfully. The C. B. & Q. railroad reports similar trouble with mogul frames, and in this case it is overcome by making the lower rail heavier and in one piece with the main frame. For ten and twelve wheel locomotives which involve greater length between the forward pedestal and the cylinders, the filling pieces are thought to be even more necessary than in mogul and consolidation locomotives, and it is believed that double front frames not provided with such bracing will give more trouble than single bar frames. Mr. Middleton, of the B. & O., advises single front frames on eight-wheel locomotives, and on ten-wheelers having a considerable distance between the front pedestal and the cylinders. Mr. Vauclain writes: "We recommend single front rails for frames on engines having a four-wheel truck ahead, and double frames for two-wheel trucks. In any case where the single front frame is radically out of line with the draw head, double frames should be used." Other correspondents generally recommend double front frames, the Erie for all classes of engines, and the C. B. & Q. on all engines having over 18 by 24 inch cylinders.

The writer believes that the following is good practice: Double rail front frames should be used on all consolidated and mogul locomotives and on heavy ten and twelve wheel freight locomotives, especially where built for mountain service. Single front frames should be used on eight-wheel passenger locomotives, as they have been found amply strong for this class of engine with good design and maintenance, and because the use of double frames would necessitate increased driver and truck weights for a given boiler capacity. The same applies to fast passenger ten-wheelers where great boiler power is desired and where close limits of weight are to be conformed to. For large ten-wheel passenger locomotives to be used on mountain work or in excep-

tionally severe service, the better cylinder fastening obtained by the double front frame makes its use advisable. Filling blocks should be used for double rail frames as before indicated, and the splices between the front and main frames should, as far as possible, be designed to avoid bending strains.

Referring to the committee's report in reference to design shown by Fig. 23, for connecting the low-pressure cylinder to lower frame by through bolts, the writer would add that this design has proved very satisfactory in service and there have been no breakages of either frames or bolts. The bolts will not be likely to break unless the frames or bolts get loose, and this will be strongly indicated by leakage of steam. Design Fig. 24 was made for a consolidation locomotive and could not be used on a ten or twelve wheel locomotive on account of truck frame clearance, as this is already small for the design shown by Fig. 23. Regarding the single rail fastening shown by Fig. 22, which avoids the bolts through the frame, this is used on 20 by 26 inch ten-wheel freight locomotives carrying 180 pounds pressure, and Mr. H. J. Small, Superintendent of Motive Power of the Southern Pacific Company, writes that it is giving "perfect satisfaction, and the same can be said of all engines to which this fastening has been applied in the last ten years."

To prevent cylinder saddles breaking, due to the expansion of boiler, some members recommend outside vertical ribs, as indicated on Fig. 5. These, with the lower cross ribs shown, and with the bolts through the outside lugs which the ribs form at the frame connections, are believed to make a very secure job.

Regarding the advisability of using cross ties front and back of cylinders or long transverse bolts through the cylinder saddles, there has been a strong expression of opinion from members in favor of using one or the other of these devices. For double front rails, cross ties lipped over the top rail and shrunk on front and back of the cylinders assist in tying the frames to the cylinders and also greatly help the connections between the cylinder saddles. The action of the steam in the cylinders tends to spring the frame sideways and to separate the cylinders where bolted together, thus practically bringing a cross-bending strain upon the saddles, and the cross ties are very effective in resisting these strains. Cast iron, although very strong in compression, is deficient in tensile and transverse strength, and it is therefore believed that wrought-iron cross ties serve a better purpose in reinforcing the cylinder saddles than would be obtained by increasing the saddle length, and with much less increase of weight. Where cross ties are used, suitable flanges, of course, should be provided on the cylinders to resist the pull of the cross ties. Inside lips on the cross ties are unnecessary, and if well fitted prevent the cross ties being shrunk on after the frames are bolted in place. The advantage of cross ties is shown from the fact that they are used successfully to hold cylinder saddles after cracking, and therefore cannot fail to assist in preventing cracking. Long transverse bolts through the cylinder saddles serve the same purpose in holding the saddle together as cross ties, and have been found very useful on many roads, but they are not thought to be as effective as cross ties, as they do not assist in holding the frames to cylinders and cannot be spaced as advantageously to resist bending strains in the saddles. They are useful, however, for cylinders having single front frame connections. Where used, they should be placed as low down in the saddle and as near the back and front as possible. With cylinder flanges arranged as in Fig. 22, cross ties lipped over the top frames could probably be used to good advantage either on single front frames or on the lower rails of double bar frames.

FIG. 1.
FRONT FRAME,
MOGUL LOCOMOTIVE.

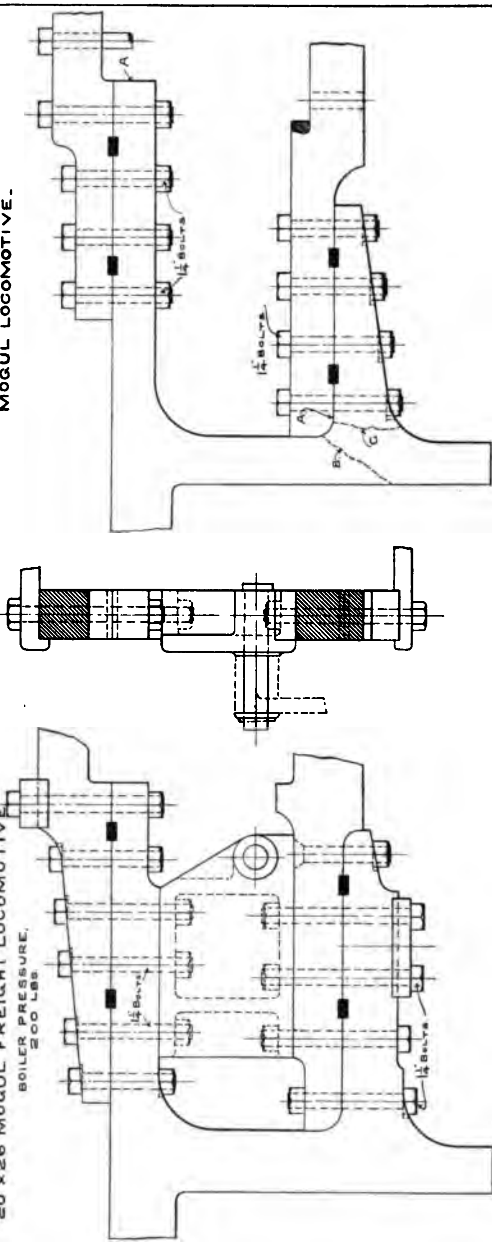



FIG. 2.
FRONT FRAME CONNECTION.
20"×26" MOGUL FREIGHT LOCOMOTIVE
BOILER PRESSURE,
200 LBS.

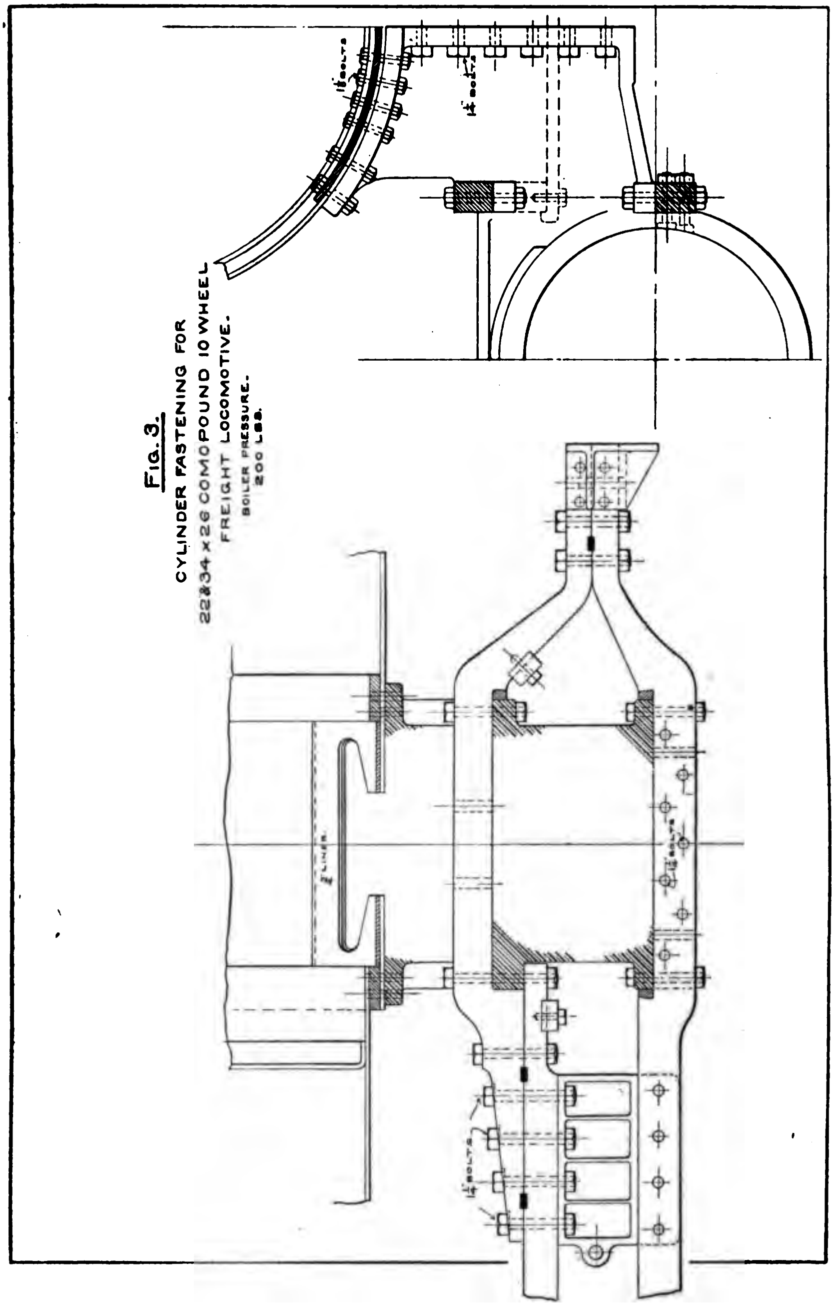


FIG. 3.
CYLINDER FASTENING FOR
22&34 x 26 COMPOUND 10 WHEEL
FREIGHT LOCOMOTIVE.
BOILER PRESSURE.
200 LBS.

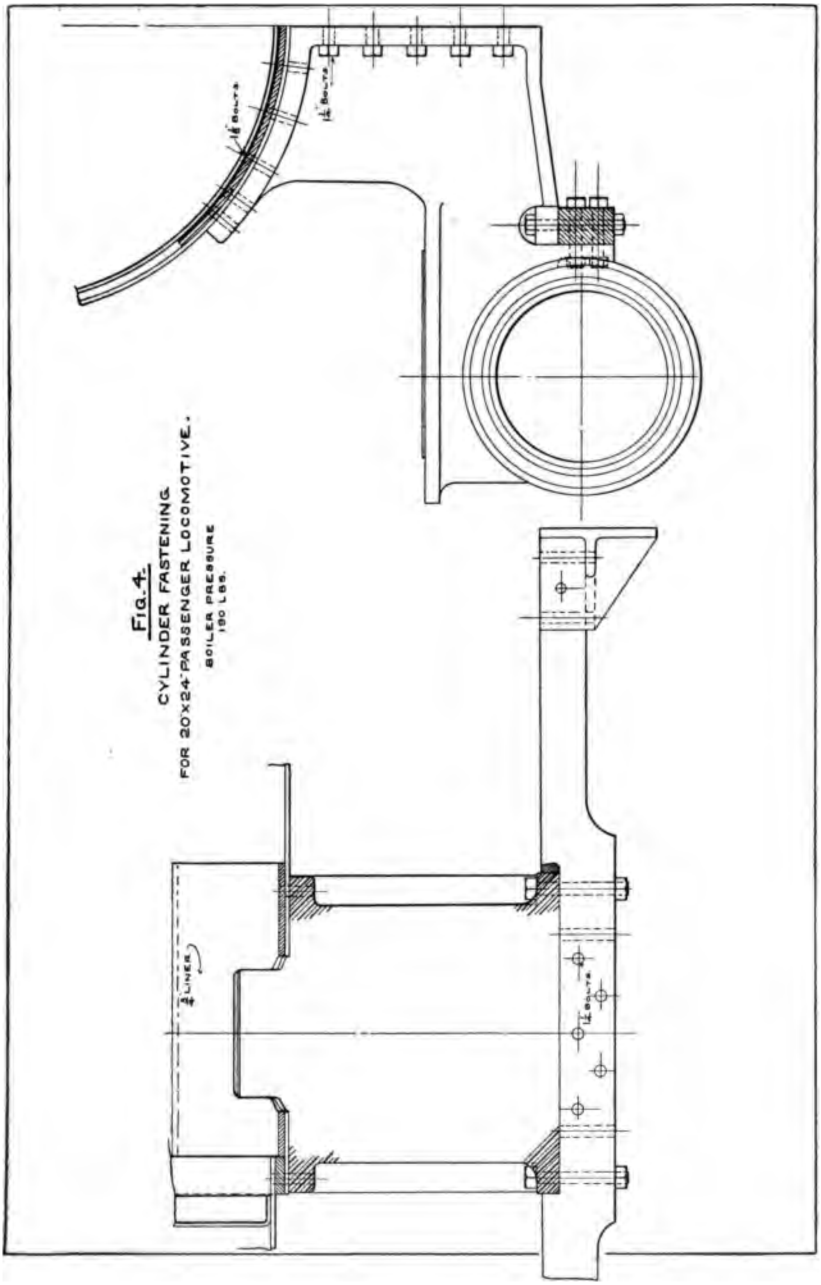


FIG. 4.
CYLINDER FASTENING
FOR 20"x24" PASSENGER LOCOMOTIVE.
BOILER PRESSURE
190 LBS.

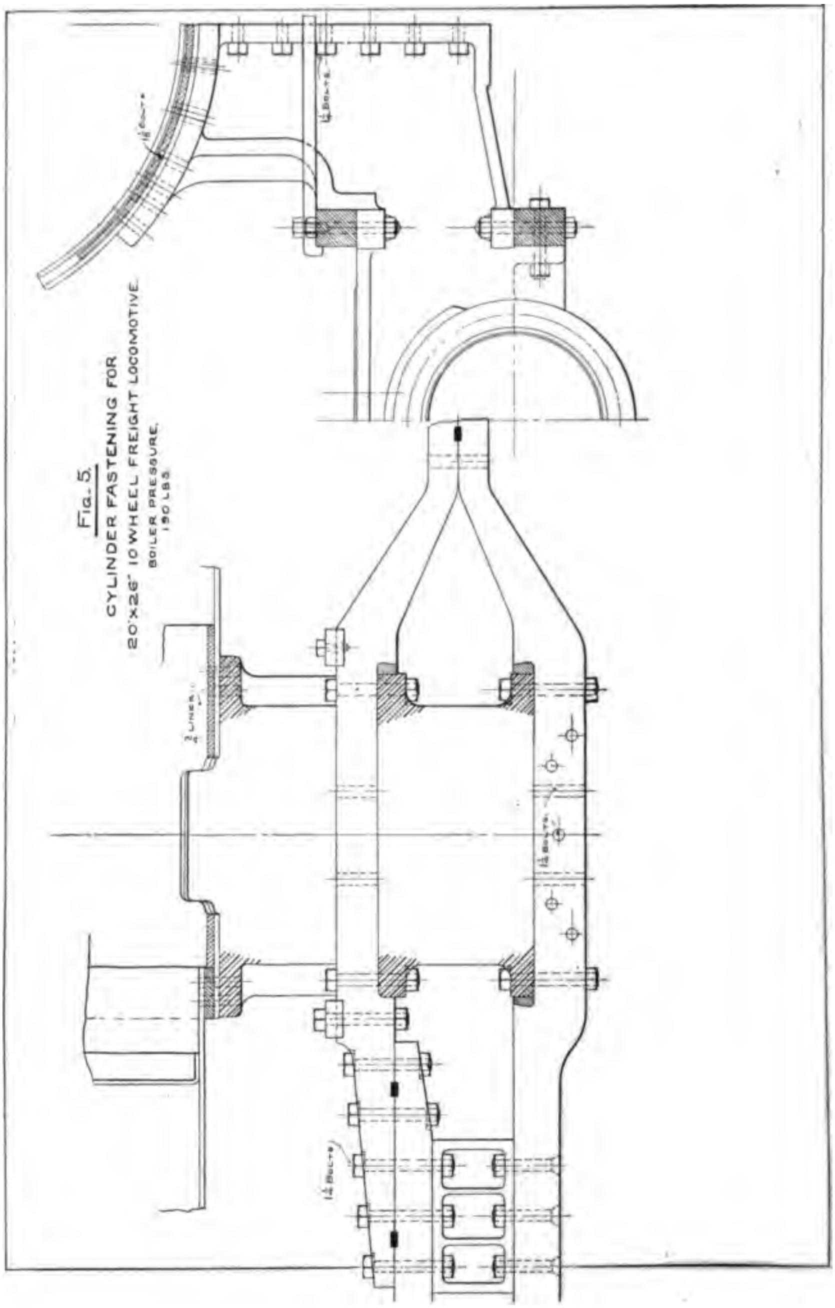



Fig. 5.
CYLINDER FASTENING FOR
20"x26" 10 WHEEL FREIGHT LOCOMOTIVE.
BOILER PRESSURE,
190 LBS.

Regarding the connections between cylinder saddles but little trouble is reported, and a single row of $1\frac{1}{4}$-inch bolts spaced about $4\frac{1}{2}$-inch centers through the back and front vertical flanges of saddles are believed to be sufficient, together with center-plate fastening, if the frames are suitably braced longitudinally with a foot plate or the equivalent. Bottom flanges, keys between the saddles or special reinforcement of the joint between the saddles seem unnecessary, especially when cross ties or transverse bolts are used as before referred to. The designs shown in Figs. 2 to 5 are believed to illustrate good practice for cylinder fastenings on the class of engines named. All of the designs have been applied to locomotives in very heavy service during the past two years and no reports of failures have been received. J. E. SAGUE.

THE PRESIDENT: Gentlemen, you have heard the report of the committee. What is your pleasure to do with it?

MR. BROWN: I move that it be accepted? (Seconded.)

The motion was carried.

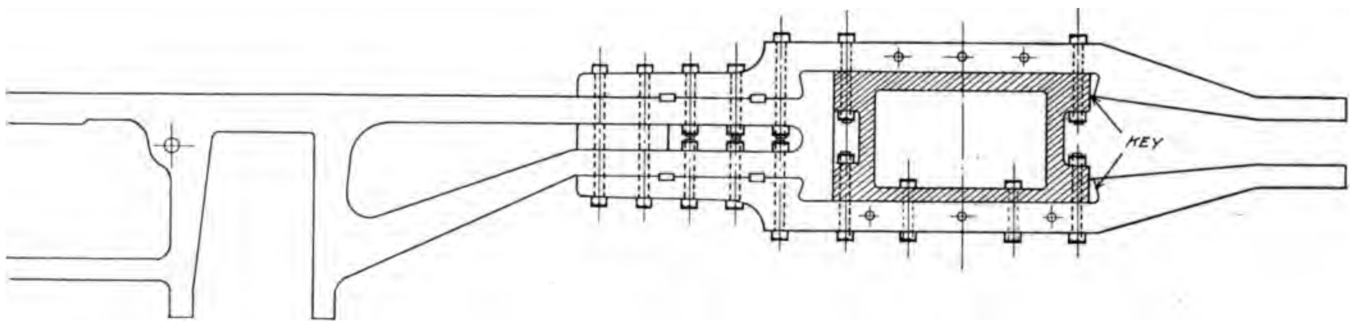
THE PRESIDENT: It is open for discussion.

MR. ATKINSON: Fig. 12, page 11, shows the inside plate of the cylinder saddle cut out in rectangular form and the bottom of it is a bar across from front to back. It struck me that in that form of construction, if your cylinder metal is hard enough to stand wear, it will be liable to break at the truck center support, to crack through the corners and break out. The ordinary form of flat surface appears to present just as good facility for bolting together with an inside row of vertical bolts which can be got at, and at the same time the weight that lies on the truck center is not liable to break it. The truck center also, if bolted only, has given trouble on our road at times. We have had one case where the truck slid back under the motion, and in consequence we let in a ring with a lug in the center. I should be pleased to send any of the members a blue print of the arrangement. And at the same time the truck center casting has, going down to the bottom of the two cylinders, a rib on each side about an inch deep which assists in holding the cylinders together at the bottom, the part which is most liable to open. We found the necessity for better bolting of cylinders and smoke boxes some eight years ago, and today we put about 21 bolts in each cylinder—42 bolts. If there is a 19-inch cylinder we put about 21 bolts, and an 18-inch cylinder about 17 or 19, and we have had very good results. The number of leaking steam pipes decreased so far that it is almost unknown with that class of engines. In addition to that, we also found the necessity of putting the cross ties on the front and back of the cylinders, the top arms where it gets a bearing on the cylinder to pull them together we shrink them on with

a $\frac{1}{16}$-inch shrink. At the bottom we just steady them with a small amount of shrinkage, about a thirty-second. We have done that with all our repair engines for some time. The frame splices on a mogul engine have given us considerable trouble, but we have got over that by lengthening the top splice over the front horn. To my knowledge, this was done first by the Baldwin Locomotive Works — a splice about 4 feet 6 inches long. It materially assists the lower bar of the frame. The frame itself is welded up in different style from anything I have seen. The front leg of the frame is welded on like a half-lap joint — like a carpenter's half-lap joint — under the hammer, and the leg itself is welded on the frame back in the same way, so that we get a much greater area of weld, and in that way have avoided the fractures that have developed from the change of direction of fiber.

MR. HENDERSON: There are two or three points in this report that I think are worthy of reference. On page 3 of Mr. Sague's supplementary paper it says: "Referring to the connection of cylinders to boiler, the replies to the committee's circular indicate but little trouble with this fastening." I think that is a very important fastening to make, and we have recently adopted the plan shown approximately in Fig. 9, although we do not have the two rows of bolts front and back on the saddle. But we put in the course number on each side between the two legs which does take a double row of bolts. Then on page 4 it says: "With double front frames these strains are exerted mostly upon the bottom rail, as this rail is necessarily much nearer to the center of the cylinder than the upper one. The bottom rail, therefore, requires nearly as much section as if a single rail only were used." Now, the line of thought there would seem to indicate that the bottom rail was simply to transfer the effort of the cylinder to the main part of the frame, whereas we know it is of considerable importance that engines which occasionally have pushing to do should transmit the energy in front to the bumper, and it is especially important in jacking up engines that we have steel connection between the bumper and cylinder, and in that case the double bar frame is, I think, much safer than the single bar. The last diagram of the report is really a suggestion by the present speaker, but is not carried out exactly with the idea which I had in mind at the time. I have a couple of prints here which I will hand around to some of the members who wish to look at them. I think that the idea is slightly lost in

FRAME FASTENING SUGGESTED BY G. R. HENDERSON
ROANOKE VA.
APRIL 1ST 1898



the last sketch. The top bar is shown all right, the idea being to maintain the main frame front to the cylinders so that that can be slotted and the cylinder faced off so as to make the cylinders perfectly square and the proper distance from the main axle. Then if the top and bottom bar of the frame were made to lip against the back frame, the keys, by being driven to the front end, would draw the whole connection up tight without depending in any way on the splice, and then the vertical bolts could be put in to consolidate the whole construction. While we have not got any engines in use at the present time with that, we are working up to such a design for an engine. It seems to me that is about the best two-bar frame fastening you can get for an engine with a four-wheel truck. I would be very glad to hear the criticisms of any of the members present in regard to that. There is a reference made on page 6 to long transverse bolts through the saddle such as shown in Fig. No. 10, and further down a reference to the keys. I think it is of considerable importance to have keys between the two cylinders, because, as we all know, there is a wobbling tendency to an engine having keys between the two cylinders. It will prevent the saddles from working on each other at the lower portion. I think it is important to have that connection between the two cylinders very rigid.

MR. GAINES: We find a single front bar frame gives less trouble on eight and ten wheelers than the double, even on heavy ten-wheelers weighing up to 75 tons. The committee discourages the use of long vertical bolts going through the frames and cylinder, but does not say how to overcome it. We are using an outside lug, to which the frames are secured by a short vertical bolt, and we find that it works satisfactorily. Another cause for breaking vertical flanges and bolts seems to have been overlooked. With heavy walls and high steam pressure, the center of the cylinder being hot and the outer walls being in contact with the cool air, there is an enormous pressure brought on the vertical flanges and bolts, due to expansion between the faces of the saddles, and acting like driving a wedge in between the cylinders at the center casting. To overcome this we are planing out pockets on the faces, allowing contact only on sides and top between the two cylinders. This is one of the most fruitful sources of broken cylinders.

MR. HENDERSON: I think if Mr. Gaines will look at Fig. 12, he will notice that an arrangement similar to what he speaks of is shown. The exhaust pipe is separated in a measure and shows the

cylinder joints at top and bottom at both ends. The idea was to prevent the expansion from forcing the cylinders apart.

MR. GAINES: I carry that all the way up within four inches of the top instead of stopping short there.

MR. ATKINSON: One thing I omitted to mention, Mr. President, is that the lug ring that we fix to truck centers acts as a key between the two cylinders.

MR. DAVID BROWN: We have had some trouble with our cylinders and frames, but we have overcome it pretty much, in fact, effectually, by using braces back and front of them, and we have followed it up to quite an extent. If you will refer to Fig. 30 — we had some consolidation engines with a splice similar to that, and we had quite a difficulty in keeping the cylinders together. There were not enough bolts in the flanges back and front of the cylinders, in our estimation, and we put more in, and that did not seem to do any good. Finally we took the bolts out of the top splice of that frame and we put a plate underneath the bar proper, and we let that plate take all those bolts in. I think there are about five bolts. We put that right on and let that plate take all the bolts and ran it across. We put in a smaller brace in the front of the cylinders. The front was not exactly like that, but the back was precisely like it. That back plate was about twenty inches wide in the back of the cylinders, and we never had any further trouble with that class of engines, but we effectually cured them in that way. We never make any attempt now to send any engine out, if possible, without the braces. We recently built an engine on which I put a plate from the front of the cylinder saddle right up to the bumper right across the two frames and fastened it there. The main reservoir was back of the cylinders, and I put another rod on the main reservoir as wide as I could get it there. It looked a good job and it will surely hold the cylinders so that they will never make any attempt to move.

MR. SINCLAIR: I move that the discussion be closed. (Seconded.)

THE PRESIDENT: It is moved and seconded that the discussion be closed, and as no questions have been raised we will not call on Mr. Sague to close the discussion. As many as are in favor of the motion will signify by saying "aye"—contrary minds, "no."

The motion was carried.

THE PRESIDENT: Gentlemen, it is getting very close to the noon hour and we will have to adjourn by at least twenty minutes of one

in order to take the train for Schenectady. It has been suggested that we take up our topical discussions now, inasmuch as we are getting well along with our reports, and probably the topical discussions will take up about all the time that can be given to them. And unless there is some objection to it, we will now open the topical discussions, commencing with the fourth subject, "The Use of Steel in Locomotive Construction." Mr. J. E. Sague has been asked to open this discussion.

MR. SAGUE: I wish I had something new to say on the use of cast steel in locomotive construction, but I have not; so what I have written here is a rehash which you are all probably familiar with already.

Mr. Sague then read the following:

Cast steel has become a most important material of locomotive construction, and the past year has witnessed marked improvements in its manufacture, and in the design of parts made of it. Probably the main advantage obtained by the use of cast steel in locomotive work is that it has permitted considerable reduction of weight in various details, and has thus allowed more weight to be put into the boiler. This, especially in passenger locomotives, has increased the efficiency of the machine by allowing the use of an amount of grate and heating surface which would be practically impossible within permitted limits of wheel weights if a stronger material had not been available to replace cast iron in such details as driving wheel centers and foot plates.

In cast steel we have a material from which can be obtained a minimum tensile strength of 60,000 pounds with an elongation approaching that of boiler plate, or we can increase the tensile strength to 90,000 pounds or more with a corresponding reduction of ductility. The best quality of cast steel for various locomotive details has not yet been fully determined; but in practice, steel of nearly the lower limit of tensile strength appears to be preferred. It would be interesting to hear the opinion of steelmakers on this point.

Aside from the aim of saving weight, cast steel is being used for many details in which cast iron has proved deficient in strength, such as main wheel centers of six and eight coupled freight engines, driving boxes and crossheads.

Cast steel is also being widely used to replace expensive forgings, and it then permits greater latitude in design than is possible with forgings, and therefore secures a better job. It is interesting to note, however, that flanged and forged steel can be used in some cases to better advantage than cast steel, especially in boiler construction for dome rings, caps, etc.

The advantages of cast steel are so well known, that it may be more profitable to mention some of the objections to its use. Cast steel has a greater shrinkage than iron, and is therefore more liable to strain in casting and consequent defects. Its rough finish compared with cast iron involves more expense in preparing the surfaces for the painter, and more imperfections for the latter to fill and cover up. The hardness and toughness of cast steel increases machine shop labor, and means more tools

for a given output. An important element to consider is the delay in locomotive manufacture and repairs caused by the extra time required to make steel castings as compared with iron, and the more vexatious delays caused by castings which develop defects in machining.

It is but fair to say that most of the above objections, though still serious, are being rapidly lessened by the great improvements in steelmaking and by the increase in capacity of the steel foundries.

THE CHAIRMAN (Mr. Quayle): You have heard the remarks of Mr. Sague on the use of steel in locomotive construction. This is a very important subject and ought to enlist your interest. We would like to hear from those who have had experience. Let us be prompt, now, and make it as interesting as we can.

MR. HENDERSON: I am afraid I am talking too much, but as no one else seems to be desirous of speaking I will say a few words. I have been very much interested lately in the use of nickel steel. We have on some recent locomotives introduced nickel steel in the main axle and in the crank pins. It has been customary in a number of recent designs to make the main axle half an inch heavier in diameter than the other axle, so as to get the parts interchangeable. It seemed that it would be desirable to make the main axle of superior material, so we made the main axle of nickel steel and the other axles of hammered iron. There was some question as to whether the nickel steel would run cool or not. Possibly some of the members can give us information as to whether nickel steel is more apt to heat than carbon steel or hard iron.

MR. ATKINSON: I would like to ask a question. Is nickel steel made use of at all in steel castings? I know that it is in steel forgings, but I have not heard of its use in steel castings.

THE CHAIRMAN: Not to my knowledge. Is there anyone here who can answer the question? I take it that it is not, Mr. Atkinson; at least not within the knowledge of this convention, anyway.

MR. WEST: The Ontario & Western are using a cast-steel driving box with most excellent results.

THE CHAIRMAN: I might say that yesterday I heard a number of Master Mechanics discussing the merits and demerits of steel driving axles. It is a subject that I am very much interested in, and I would like to hear from those who are using them. Some say that they have not been able to use them because they are running hot continually. Others say they have no difficulty whatever with them. And that is what we are here for, gentlemen, to get all the information we can

concerning these things, and if you have any data on this line we would like to have it.

MR. WEST: I would like to say to the Chairman that we are using cast-steel driving axles, and until we began to finish them with a roller we had trouble with hot boxes. Since we have been using the roller as a finish we can use them on the fastest trains we have without any difficulty.

MR. DAVID BROWN: I would state that we use steel entirely for our axles on the division I am on — driving axles, tender and truck axles. We have good results. We find that if there is any little trouble there is less of it in the appearance of the axle than the iron gave us. For instance, if an iron axle is hot we would find when we examined it that it was open — seamy — little scales on it that we could pick off, a certain looseness; it was not homogeneous. But you do not find that with the steel, and the steel is giving very good results.

MR. ATKINSON: Mr. Chairman, I think Mr. West said that he used cast-steel driving axles. I do not know if he meant that. Did he mean cast steel or forged?

THE CHAIRMAN: Driving boxes, he said. Did you say cast-steel driving axles, Mr. West?

MR. WEST: No, sir. I did not mean to be understood as saying that we used cast-steel driving axles.

MR. ATKINSON: We have long discontinued the use of iron for axles of all kinds — I suppose for eight years and over — and we have had very good results with the steel if we take care to test it high enough, and in my opinion the test generally prescribed for steel axles is only sufficient to distinguish between a bad one and a poor one. If we made that test trebly as hard we should then begin to know what the quality of the metal was; because we probably pass the axle through half a dozen blows of 25 or 27 or 30 feet, according to the diameter of the axle, then lifting the weight to 40 feet and it may take 20 to 40 blows to finish it up. That shows that the test is scarcely sufficient to distinguish what the material is that we are dealing with. Of course, some years ago we would have one to go at one or two blows, but you could scarcely denominate that steel. With regard to the rolling of the bearings we have very good success with it. I have also extended it to the rolling of the piston rods with equal success. It makes the most nicely finished piston rod we can think of. We are going into the rolling of the valve rods also.

Mr. Manchester: I would like to ask a question as to whether members who have had extensive experience in the use of steel have any data relative to the wear of the bearings as compared with the iron axle, and I would also like to ask the member who is using the steel driving boxes if they put anything on the face of the box or on the hub of the wheel to protect the wheel with the two steel surfaces together — that is provided they use a steel wheel center; also what material they use for shoes and wedges, and if the result with them is entirely satisfactory.

The Chairman: You have heard the questions. Are there any gentlemen who will answer?

Mr. Hennessey: I would say we are using the steel axles on the Michigan Central for driving axles and truck axles with very good success, and have experienced no trouble whatever from the box heating on account of using steel axles, and I think we are getting better success than we formerly had with the iron axle.

Mr. Sinclair: Mr. President, there has been a great deal of prejudice among American Railway Master Mechanics, among many of them anyhow, against steel, on account of the bad luck they had with it some ten or fifteen years ago, when steel castings were pushed upon them before the art of casting soft steel had been acquired. It is wonderful how much that experience has influenced the great mass of them against steel of all sorts for rolling stock. The prejudice is going off very rapidly in some quarters, for I may mention for general information that in visiting the Baldwin Locomotive Works a few weeks ago I found that about ninety per cent of the locomotives on the floor had cast-steel centers, and cast steel entered very largely into the construction. In fact, wherever a casting could be made more cheaply than a forging they seemed to be using steel. Some of the builders speak very favorably of cast-steel frames, and I have no doubt but that the day is very near when cast-steel frames will take the place of forgings. The forging of a frame has always been an unsatisfactory operation, and when it was finished it was always uncertain whether there was much strain set up in it that would prove fatal to the frame itself and cause a great deal of delay from having it taken down to reweld it. In regard to the prejudice against steel axles, it is a strange thing why it should prevail to such an extent, for in nearly all foreign countries there are practically none but steel axles used. I have had considerable experience in looking at rolling stock abroad in the last few years, and there it is the exception to find an iron axle, and the

railroads in nearly all the countries in Europe are getting rid of the iron axles just as quickly as they can get them worn to the condition where they can be profitably abandoned. I think it is more light that is wanted to make our American Master Mechanics and designers agree that steel is the proper material for axles. The only difference between steel and iron really is that iron contains a certain quantity of cinder that adds in no way to its strength, and why a material containing a weakening substance should be preferred to one that has none of the weakening substance is one of the mysteries hard to understand. [Applause.]

MR. MORRIS: I am very glad that Mr. Sinclair referred to the use of steel so generally on the other side. Now, we are using both wrought iron and steel, and I think we have had better results from good steel. It is a pretty hard matter to follow up all kinds of steel. For instance, we purchase steel in accordance with our specification which we think is about what we want, and we make all the tests that are possible for us to make, and we find, in a good many instances, that steel does not give us as good service as some of the special steels. The percentage of breakages of piston rods was very great on our line, and I thought about a year ago I would try some of the special steels. I do not know that there is anything particular in the make-up of the steel except in its treatment. I put in some of the Coffin steel that gave some very good results. Of course, it costs more than the open market steel does. I have heard very little said about the nickel steel that is coming into the market, and while it has been represented as a pretty good article for axles and barrels, I think that if any of the members have had any extensive use of these special steels I would like to hear them say something about them. The special treatment of the Coffin axles indicates to me a very much better condition of the axles and the material generally than the everyday open specification axles.

MR. MCINTOSH: I am of the opinion that it will not remain very long a matter of choice as to whether steel or iron will be used for axles and crank pins, for the reason that there is so much steel scrap in existence at the present time that it is almost impossible to eliminate it from the iron and obtain the pure scrap that we used to be able to procure. For this reason alone, if for no other, in the near future iron will have to be abandoned for that purpose.

MR. WAGNER: Is this topic on the question of steel castings, or does it include the subject of open hearth steel axles?

THE CHAIRMAN: It is the use of steel in locomotive construction.

MR. WAGNER: My friend Mr. Sinclair referred to slag as a dangerous element which we do not have in steel. I believe we do have it in the form of phosphorus in the core. In making a drop test I was very much surprised to see the end fly off of an axle on the first blow, and the only way that it was explained was on the ground of that element of phosphorus. So that we have not eliminated dangerous elements altogether.

MR. ROBERT MILLER: Mr. Chairman, I think if Mr. Sinclair had had some of our experience some twenty-five or thirty years ago in the use of steel for axles and crank pins and the like, that he would not wonder at the conservatism of Master Mechanics and Master Car Builders in respect to its use. Of course, I believe now that the manufacture of steel is so much improved that there is no question but that it is superior to iron for axles or crank pins, or anything of that kind. We are using the Coffin process steel axles and crank pins with great success. We have had no trouble with them. We were driven to it by the fact that we could not get what we considered good wrought iron. We are just building three engines, putting in the nickel steel for crank pins. We do not know what it will do. We believe that it is good. Mr. Manchester asked a question about the wearing surfaces between the driving wheel centers and the steel driving wheel box where the two are of the same metal. We find that we cannot run them together successfully. If the driving box and the steel center are cast steel, we have to put in a liner between them before we can make them run successfully.

MR. SINCLAIR: Mr. President, if there is anyone running a cast-steel axle box on cast-steel centers, I should like to know where it is. I have been around a great deal, perhaps as much as any of you, looking at different shops and engines in the last two years, and I never saw cast-steel centers used with a cast-steel axle box but what a soft liner was necessary.

MR. MANCHESTER: What about the wedges and shoes?

MR. ATKINSON: We tried cast-steel boxes a number of years ago and use them to some extent at present, but not exclusively by any means—in fact not more than twenty-five per cent at the outside; and we had very great difficulty with the cutting of the wedges and we have it to some extent today. It depends on the personal factor of the engineer whether the wedges act or not, unless you put something

on to protect them. We babbitt all wheel hubs, whether cast iron or steel, and we have effected a very great economy by doing so. We have to allow rather more clearance when the engine goes out than we formerly did, probably three thirty-seconds, to allow for the tilting of the wheels on a rough road; but it will come into the shop again in a year or in a year and a half, and the driving wheels are a very fair fit to the box sidewise.

THE CHAIRMAN: We have spent a quarter of an hour on this topical subject and brought out a number of good points.

The minutes show that the application of electricity for steam railroads was made last year a part of the programme for this year, and we will now introduce that topic. Mr. Brangs will open the discussion.

MR. BRANGS:

THE APPLICATION OF ELECTRICITY TO STEAM RAILROADS.

The paper that I presented to this Association at Old Point Comfort last year was an outline of the possibilities which might be put to practical use on various steam railroads in this country. The practical results accomplished in this line of work for the past two or three years stand preëminently before the American railroad man not as an illusion, but a fact.

In reviewing this subject and bringing before you the many advantages that can be obtained by the use of electricity for railroad traction, it is safe to say that the possibilities in the near future will overstep expectations of even the most sanguine engineer. My object today is to bring before you to review, briefly as possible, the various methods by which electricity can be applied for heavy railroad work.

The transmission of electrical energy is an important feature of electric traction, and by means of the three-phase alternating system, which within the past three or four years has been developed to that extent that it is possible to generate and transmit it for long distances economically and efficiently. As regards the generating of this three-phase alternating current and the method of transmission, it is quite within the practical limits to produce as high potential as 15,000 or 20,000 volts, or it may be generated of, say, 200 to 500 volts. In the latter case, to secure economy of transmission for long distances, it would be passed through step-up transformers, and the voltage could then be raised to whatever potential desired, and so transmitted over the lines, then passed through step-down transformers, and the voltage reduced to whatever might be suitable for the purpose at hand.

To derive direct current from alternating current, a combination alternating and direct current machine, called a rotary converter, is used. The efficiency of a three-phase transmission and rotary-converter system may be considered eighty to eighty-five per cent, and it is within the limits of the present practice to operate railways fifty miles from the source of supply.

The current now generated at Niagara Falls is being transmitted by the three-phase alternating system, and transmitted at 10,000 volts to the city of Buffalo, and

is used to drive cars between Niagara Falls and Buffalo, as well as for other useful work.

Touching the value of electricity for railroad work, the question of cost of operation is, of course, very important, and I think it may be fairly said that from the indicated horse-power of the engine to the mechanical energy at motor car the efficiency of transformation will be from fifty to fifty-five per cent. Steam locomotives, including all losses, give about the same net efficiency as applied to hauling the trains. Assuming an equal net efficiency by both systems, you would have the advantage in the electric traction of the compound condensing engine, cheaper coal and a type of boiler enabling you to burn your fuel to the best advantage.

Roughly estimated, I believe that a ton-mile can be operated by the electric system for less than one-half the cost for fuel, and the total cost of electric power, including all power-station expenses, would not exceed three-quarters the cost of coal for the steam locomotive.

Of the various systems now in use, the most popular seems to be the third-rail system. The first extensive road equipped in this manner was the Intramural Elevated Railroad at the Columbian Exposition 1893. The demonstration made at that time encouraged the owners of the Chicago Elevated Road to adopt electricity.

They discarded their steam equipment entirely, and with the exception of some difficulty they had in the beginning from the fact that the motors were too light for the work, have been running successfully ever since. The experience gained by the operation of the Chicago road during the last two years has thoroughly established the economy and desirability of using the electric motor for elevated service. The subject is of special interest at this time, because of the adoption of electricity by the elevated railroads of Brooklyn, and the probable adoption of electricity by the Manhattan Railway, New York City.

All elevated railroad construction is practically on the same plan; the structure being made of steel girders supported on posts at intervals with wooden ties laid upon iron stringers, an ordinary T-rail spiked to them. The trains are usually composed of five cars, weighing when loaded about one hundred tons, drawn by a locomotive, weighing twenty-three tons, with about sixteen tons of its weight on drivers. These trains ordinarily make their schedule speed of thirteen miles an hour, but during the busy hours of the day drops down to about nine or ten miles an hour.

There are two reasons for the adoption of electricity for elevated service: one to reduce the cost of operation; the other to increase its schedule speed to the utmost limit.

The increased rapidity in the movement of the trains will, for the same service rendered, reduce the train expenses very materially. The decrease in the running time of the trains must be made principally by stopping and starting, which means greater acceleration. Some recent acceleration tests have been made of standard car motors which are forty per cent better than could possibly be obtained with steam locomotives.

During the past year some practical acceleration tests were made with the standard American railway type of car provided with four 50-horse-power 500-volt 90-ampere motors mounted two on each of the trucks. On each armature shaft was a 33-toothed pinion meshing into a 52-toothed gear fixed to its respective axle. The total weight of the loaded car was twenty-five tons, including trucks, motor and

passengers. The only departure from the ordinary practice was to reduce the gear ratio and use a controller which would admit sufficient current to give the required starting torque. The acceleration obtained was at the rate of thirty miles per hour at the end of ten seconds. Five seconds after the controller handle was moved the car had obtained a speed of nineteen miles per hour; at the end of ten seconds, thirty miles per hour; fifteen seconds, thirty-five miles; twenty seconds, thirty-eight miles; and twenty-five seconds — or five seconds less than half a minute — a speed of $40\frac{5}{10}$ miles had been obtained.

These figures convey no real idea of the rapidity of the start; however, a comparison with acceleration on steam roads may serve to bring out this point. An ordinary train seldom exceeds a speed of ten miles per hour at the end of ten seconds — just one-third the speed attained by the test car. In a similar test with a Manhattan Elevated train, at the end of twenty seconds the speed was only 13.5 miles per hour, during which time 198 feet had been covered as against thirty-eight miles and 356 feet in the case of the electric car.

The sensation due to these rapid starts was not unpleasant, and as the starting was perfectly smooth even while standing in the car one would not be inconvenienced by this rapid acceleration that is now the case with trains drawn by slow-starting locomotives.

The Brooklyn Elevated Railway Company are equipping their roads with what is known as the Multiple Unit System. This invention is the product of that eminent and pioneer railway electrical engineer, Frank J. Sprague. I think it would be opportune to dwell on this system for a moment. Each car is equipped with its complete complement of motors, controllers and air-brake apparatus. Each controller is operated by a little pilot motor whose movements in the direction of on or off position are determined by an electric current sent to it through wires leading from the operator on the front end of the train. There are certainly advantages to be gained by the use of this system — having a motor on every axle and having some method of simultaneous control of all motors, particularly independent equipment; unlimited length of trains, high tractive accelerated effort, reduced strains, smoother motion, etc.

As regards the use of this system for heavy train service I see no reason why it could not be used to the very best advantage. The making up of trains for the various demands made upon the railroad companies for quick and effective service for all length of trains and the convenience by which such trains could be handled, would make it appear as though the Multiple Unit System would be applicable to all kinds of suburban and interurban service.

I wish to state briefly some well-settled facts in reference to the electric motor. The dynamo or motor (interchangeable terms for the same machine), variously proportioned to meet the conditions of duty imposed upon it, has a modern useful life of scarcely a score of years. The use of this remarkable machine as a generator of electricity preceded in a commercial way its use to any wide extent as a motor. Only thirteen years have passed since it began to have any standing for stationary motor purposes, and it has been but nine years since the building of the pioneer Richmond Electric Railway, which gave the impetus to one of the most remarkable industrial developments which have afforded one of the main reasons for the glowing predictions of the future of electricity. The design and manufacture of the electric

motor presents no peculiar difficulties. It can be built singly or in combination of any desired power per unit; it is reliable; it has a smoother torque than a locomotive and can be worked for longer hours; it can be controlled automatically, or at will, in one or more units, by very much less skilled labor. I consider its depreciation very much less than that of a locomotive; its cost is reasonable, and will be very much further reduced.

As regards the means and method of operating trains, whether by a third rail, the overhead trolley, the surface-contact system, or whatever other way may be used, the problem is largely one of collecting the current, i. e., securing proper contact between the moving and the fixed conductor.

For very heavy work, whether the speed be fast or slow, the third rail has some special advantages. Almost any amount of current can, practically, be collected. In the third-rail system, as in use on the Hartford & New Britain Division of the N. Y. N. H. & H., as well as that used in the present existing electric elevated trains, there is simply a plain surface of rail and upon this bears a cast-iron shoe, weighing fifteen to twenty pounds, which is dragged along by the car. This method of collecting the current has not given the slightest trouble. The maintenance does not amount to anything to speak of, as the shoe lasts a year or more, and the only cost is that much cast iron, of which they are made.

As regards the question of insulation or leakage likely to take place from the third rail: The experience of the elevated railroads of Chicago and Hartford has been that wooden blocks three or four inches high, in conjunction with the tie, upon which they rest, afford ample protection.

As regards the success of the installation of the electric system on the N. Y. N. H. & H. road, it may be of special interest to you to know that previous to operating the trains by electric motors, the travel between New Britain and Hartford amounted to about eight hundred passengers per day (the steam service consisted of three-car trains, weighing in the neighborhood of two hundred tons, while the electric motor cars weigh only twenty-five tons), and since starting the electric system, traffic has increased from about eight hundred to three thousand passengers per day. The public appreciate the vast difference between the clean, effectual electric service, with its absence of smoke and cinders, and the regular steam locomotive service. The comparatively frequent service, also, of course, is a great inducement.

In conclusion, I might say that motors or motor combinations can be built which will surpass in power and in tractive and speed capacity any steam locomotive which it is practical to construct and operate. The necessary power can be efficiently and effectively transmitted for reasonable distances electrically. Increase of traffic requirements and the spur of competition are continually making necessary improvements of a character favorable to change of motive power. Electrical locomotives and cars can be built with multiple motor, power controlled and individualized, they can be so arranged that two or more can be operated at will or automatically from either end and from any situation on the train.

THE PRESIDENT: Do you wish to discuss this paper?

PROF. HIBBARD: I think that I would feel like taking issue with the gentleman in expecting the adoption of electric traction for our steam roads for anything other than suburban service, but for suburban

service I believe it is to the shame of our steam railroads that they have allowed the electric trolley companies to get ahead of them. I have been living for the past three years in the city of Minneapolis, and every day I had to pass by a rotting steam railroad station a little out of the center of the city, which is a monument to the way the electric companies have got the best of our steam railroads, and I think it is to the shame of the steam railroads connecting St. Paul and Minneapolis, ten miles apart, that they have permitted the Interurban Electric Railway to get almost all the passenger traffic. The Interurban cars are just about as large as an ordinary passenger car, and I have seldom been on one of those cars when it was not comfortably filled, often extremely crowded, and they say it is the best paying portion of the electric system of Minneapolis and St. Paul. It takes about forty minutes to get from the center of one city to the center of the other, a distance of ten miles. The steam railroads connecting those two cities had their own lines protected by overhead crossings, on which they could run fast, and yet they permitted the electric roads to get the traffic from them when they could have had it themselves. In illustration of the importance to my mind that electric traction has for suburban service, I introduced in the course of mechanical engineering in the University of Minnesota a required course in electric railways, electric motors and electric transmission of power, just as thorough as students in electrical engineering get there, and the same thing will be required, commencing next fall, for the railway mechanical engineering course at Cornell University. I do not believe, however, that electric traction is in the near future to be found on trunk lines. In conversation with the electrical engineer of one of our largest trunk lines here in the East last Thanksgiving time he told me — of course he is an electrical engineer, and electrical engineers are very hopeful — that he did not believe it was in sight with them. He said if it did come the method would be pursued something like this: In the case of two cities, say ninety miles apart, they would put in three large stations. In a large station there would be two kinds of dynamos, one producing the ordinary electric car current which would operate the electric system five miles each side of this main central station. Then ten miles each side of this main central station there would be rotary transformers, and a current would be generated in the main central station, an alternating current of high pressure, say 7,000 volts, which would be transmitted ten miles each side of this big central station to the rotary transformer and there would be transformed to an ordinary electric railway current. Thus you see

there would be thirty miles operated by that one central station, fifteen miles each side of it, the thirty miles being divided into six sections of five miles apiece.

THE CHAIRMAN: I have no disposition to curtail the discussion of this subject, but I thought as there are so few here it is hardly worth while continuing. Before I give you an opportunity to present a motion to adjourn, I want to call the attention of the few who are present to the lecture in this building at 8:15 this evening by Professor Goss. A motion to adjourn would be in order.

On motion of Mr. Henderson, the convention adjourned until the following day.

## THIRD DAY'S PROCEEDINGS.

The convention was called to order on Wednesday, June 22, at 9:15 A.M.

THE PRESIDENT: We will listen to the report of the Committee on Resolutions and Correspondence.

Mr. Sinclair read the following report:

### REPORT OF COMMITTEE ON RESOLUTIONS.

In recognition of the courtesies and hospitality of those who have contributed to the success, comfort and pleasure of the thirty-first annual convention of the American Railway Master Mechanics' Association, it is

*Resolved*, That the thanks and fullest appreciation of the Association be tendered to Mr. R. C. Blackall for his untiring efforts on behalf of those attending the Association who have enjoyed his numerous acts of kindness and hospitality;

To the officers of the Delaware & Hudson Canal Company; to the Central and Trunk Line Associations; to the Fitchburg Railroad Company; to the New York Central Railroad Company; to the Lake Shore & Michigan Southern Railway Company; to the Michigan Central Railroad Company; to the Pullman Palace Car Company; to the Wagner Palace Car Company; to the Albany Day Line of Steamers, for transportation courtesies;

To the Schenectady Locomotive Works for their princely hospitality, and to the General Electric Company for the kind permission to visit their works;

To Bishop Newman for his courtesies connected with the opening exercises;

To Professor Goss, of Purdue University, for the excellent lecture which he delivered at the request of the Executive Committee;

To the *Railway Age* for the publication of our proceedings, and for the interesting articles and items concerning the convention published in the daily edition;

To the Committee of the Railway Supply Men for the entertainments provided for members and their friends and for the moderation displayed in their courtesies;

Lastly, to the President and officers of the Association for the able manner in which the business of the convention was conducted.

ANGUS SINCLAIR.
A. M. WAITT.

THE PRESIDENT: Gentlemen, you have heard the report of the Committee on Correspondence and Resolutions. What is your pleasure to do with it?

MR. SETCHEL: I move its adoption.

The motion was carried.

THE PRESIDENT: We will now listen to the report of the committee appointed on Recommendations from the Chair. I would ask the chairman of that committee if he would prefer to wait until there are more here.

MR. SETCHEL: I should very much prefer to wait.

THE PRESIDENT: We will pass that, then, and we will listen to a letter that has been sent from parties who want our Western friends to stop over at the Exposition at Omaha.

MR. CLOUD: This is addressed to the Master Mechanics' Association, and it has reference to certain Western woods used in a car on exhibition at Omaha, and wishes that the members would take an opportunity to see these different woods and their applications. I hardly think it is worth while to read the letter. That is all there is of it. The letter is from Dubuque, Iowa, written by the St. Paul & Tacoma Lumber Company.

THE PRESIDENT: We will proceed to the regular order of business and listen to the report on Air Brake and Signal Instructions. Mr. Waitt, will you present that joint report?

MR. WAITT: Mr. Chairman, as it will be noticed, the report of the committee is a joint report in connection with a committee who reported similarly to the Master Car Builders' Association. The Master Car Builders' Association, after consideration of the reports decided to submit it to letter ballot for recommended practice of the Association. The report which was made last year was criticised somewhat, and careful consideration was given to the various criticisms made and the ground was gone over and certain modifications made. It is suggested that the members might like to hear the two parts, instructions to engine men and instructions to engine house foremen, read. If that is the wish I will read those parts showing the changes that are recommended so that we may note them carefully.

Mr. Waitt read the parts referred to of the following report:

## JOINT REPORT OF COMMITTEES ON REVISION OF AIR BRAKE AND SIGNAL INSTRUCTIONS.

*To the Presidents and Members of the Master Car Builders' Association and American Railway Master Mechanics' Association:*

The committees appointed by both Associations to revise the Air Brake and Signal Instructions have jointly agreed to recommend certain changes in these Instructions.

A joint meeting of the two committees was held in Chicago, March 14, 1898, at which were present —

G. W. Rhodes (Chairman), S. M. P., C. B. & Q., Aurora, Ill.

C. H. Cory, S. M. P., C. H. & D., Lima, Ohio.

E. W. Grieves, Galena Oil Company, Baltimore, Md.

William Garstang, S. M. P., C. C. C. & St. L., Indianapolis, Ind.

J. E. Simons, A. M. C. B., P. & L. E., McKee's Rocks, Pa.

J. A. Chubb, Superintendent Air Brakes, M. C. R'y, Detroit, Mich.

W. J. Hartman, Air Brake Instructor, Big Four R'y, Indianapolis, Ind.

A. J. Cota, Air Brake Instructor, C. B. & Q., Aurora, Ill.

In order to condense the report as much as possible, where no mention is made of any rule or section, the committees intend that no change shall take place.

### GENERAL INSTRUCTIONS.

At the bottom of page 147, in third paragraph, after the word "information" erase the words "has been" and substitute the words *will be.*

Page 147, in the second line from the bottom, after the word "railroad" insert the following: *whose duties require a knowledge of the operation and maintenance of the air brake and air signal,* will be furnished with a copy, etc.

### INSTRUCTIONS TO ENGINEMEN.

Page 148, in first paragraph, second line, erase the word "locomotive" and substitute the word *engine.*

In the last line of the first paragraph, make the line read, "less than *six* inches, nor more than *nine* inches," and add the following to the paragraph: *They must also know that the air signal responds properly by opening the stopcock of the air-signal train line.*

In paragraph, Making Up Trains and Testing Brakes: Cross out the words "70 pounds train-pipe pressure" and insert the words *not less than 90 pounds main reservoir pressure.* Cross out the words "with the handle of the engineer's valve standing in position 2, before connecting to the train," and insert the following after the word "engine": *when connected to the train.*

In the fourth paragraph, third line, change the figures "20" to *25.* The sentence will then read, "apply the brakes with full service application of not less than *25* pounds reduction," etc.

In the second line from the bottom, change the word "engine" to *locomotive.*

Page 151, under the heading Double Headers, change the word "engine" to *locomotive* in the first and fourth lines.

Page 152, change the word "engine" to *locomotive* in the first line; also make the same change twice in the fourth line from the top.

In the second paragraph, cross out the words "and coupling" after the word "hose" in the first line and after the word "hose" in the third line, and insert the word *complete* after each. The paragraph will then read as follows:

"An Extra Air-Brake Hose *complete* must always be carried on the *locomotive* for repairs in case of a burst hose. Upon *locomotives* having the air signal, a signal hose *complete* must also be carried for the same purpose."

## INSTRUCTIONS TO TRAINMEN.

Page 152, in paragraph, Making Up Trains and Testing Brakes, change the word "engine" to *locomotive* in the first line.

Page 153, in paragraph immediately below Fig. 6, in first line after the word "than," cross out the words "the division time card specifies" and insert *provided for by special instructions.* The sentence will then read: "The air brakes must not be alone relied upon to control any freight train with a smaller proportion of cars with the air brake in service than *provided for by special instructions.*"

Paragraph, Detaching Engine or Cars: Omit the last sentence, commencing with the words "If the brakes have been applied," etc. In the heading change the word "engine" to *locomotive.* The paragraph will then read:

"DETACHING *Locomotive* OR CARS.— First close the cocks in the train pipes at the point of separation, and then part the couplings invariably by hand."

Page 154, in paragraph, Brakes Sticking: Cross out the words "in the train" and insert *by special.* The sentence will then read: "If brakes are found sticking, the engineer must be signaled 'brakes sticking,' as provided for *by special* rules."

Fig. 7. Insert *position 1* and *position 2*, which are referred to on page 156 under paragraph, Pressure Retaining Valve.

Page 155, in paragraph, Burst Hose: Add the following to the end of the paragraph: *One extra air-brake hose complete should be carried by all crews, and one extra signal hose complete carried by passenger crews for repairs.*

## INSTRUCTIONS TO ENGINE HOUSE FOREMEN.

Page 155, in paragraph, General: In the second line, change the word "engine" to *locomotive.*

In paragraph, General: In fourth line, after the words "air-tight" insert the following: *duplex gauges tested every thirty days*, so the last sentence will read: "It must be ascertained that all pipe joints, connections and all other parts of the apparatus are air-tight, *duplex gauges tested every thirty days*, and that the apparatus is in good working order.

Page 156, in paragraph, Adjustment of Brakes: In the third line from the bottom, after the word "less," cross out the words "than five nor more than," so that the sentence will read: "The tender brake must be adjusted by means of the dead truck levers, so that the piston travels not less than *six* inches when the air brake is applied and the hand brake is released." In the last line change the word "eight"

to *nine*. The sentence will then read: "This adjustment must be made whenever the piston travel is found to exceed *nine* inches."

In paragraph, Brake Cylinders and Triple Valves: In the last line change the word "engine" to *locomotive*.

In paragraph, Draining: Make the last line read: "and the train pipe under the *engine* and tender blown out."

In paragraph, Air Signal: Change the first sentence to read as follows: "The train air signal apparatus must be examined and tested by *suitable appliances from both the head end of the engine* and rear of the tender to *know* that the whistle responds properly."

INSTRUCTIONS TO INSPECTORS.

In paragraph, General: On the second line, immediately preceding the words "conductor's valve," insert the words *triple valve*.

Make the third paragraph, under the heading General, read as follows: *Special rules will* specify the smallest proportion of freight cars, with the air brakes in good condition, which may be used in operating the train as an air-brake train.

Page 157, in paragraph, Making Up Trains and Testing Brakes: In the fourth line, after the words "dummy couplings," insert the words *if so equipped*. In the third line, after the word "closed," insert the words: *The inspector must know that the air is passing through the pipes to the rear end*. In the next sentence insert the word *fully* before the word "charged," so that it will read: "After the train is *fully* charged, the engineer must be signaled to apply the brakes."

Page 157, in paragraph, Cleaning Cylinders and Triple Valves: Substitute the word *bleed* cock for "small" cock.

Insert a new paragraph, as follows:

*Graduating Springs.—The graduating springs in the Westinghouse quick-action freight triple valves are No. 15 B. W. G. brass wire, 14 coils, 3 inches free height after taking permaneut set; and in passenger No. 14 B. W. G., 12 coils, 2½ inches free height after receiving permanent set.*

In paragraph, Adjustment of Brakes: In the fourth line, omit the word "live," and in the fifth line make the figures "1½ inches" read *1 inch*. Make the last sentence read as follows: "When under a full application the brake-piston travel is found to exceed *nine* inches upon *passenger or freight cars*, the brake shoe slack must be taken up and adjustment so made that the piston shall travel not less than *six* inches. *In taking up the brake shoe slack it must never be taken up by hana brakes.*"

GENERAL QUESTIONS.

Insert a new question, as follows:

*44a. Q. From where does the air signal apparatus receive its pressure?*

*A. From the main air reservoir through the reducing valve.*

In Question 53, change the word "house" to *hose*.

In the answer to Question 57, erase the words "West Virginia" and substitute the words *a good quality of*. Erase the word "must" in the second line, and substitute the word *should*.

In Question 60, change the word "the" to *an*, so that it will read: "Why is *an* equalizing engineer's valve better than the older forms?"

In question 61, change the word "the" to *an*.

In Question 67, change the word "engine" to *locomotive*.

Make Question 69 read: "When the locomotive is coupled to the train, why is it necessary to have *90 pounds or more* pressure *in* the main reservoir?

In the answer to Question 74, change the words "six or eight" to *five to seven*. It will then read: "by applying them lightly at first with *five to seven* pounds reduction of air in the train pipe," etc.

In Question 80, change the answer to read: "By placing the handle on the engineer's valve in *full release position No. 1 for a few seconds and returning it to the running position No. 2.*"

In Question 85, change the word "engines" in the first and second lines of the question, to read *locomotives*; also make the same change in the first and second lines of the answer.

Insert a new question and answer as follows:

*93a. Q. Should the train pipe pressure exceed the maximum of 70 pounds, where would you look for the cause of the trouble in the Westinghouse F 6 brake valve?*

*A. Either the supply valve needs cleaning, the rotary disk valve is unseated, or the gasket between the main reservoir connection and chamber D is defective; or the feed valve attachment case gasket is defective; or the regulating spring below the piston needs adjusting.*

In the answer to Question 97, change the word "engine" to *locomotive*.

In the answer to Question 111, the first line, change the word "engine" to *locomotive*.

In the answer to Question 114, change the word "one" to *two*. It will then read: allowing *two* full seconds to elapse between pulls.

Insert five new questions and answers as follows:

*121a. Q. What is the difference between the Westinghouse quick-action passenger and freight triple valve?*

*A. The passenger triple valves have larger ports and slide valves.*

*121b. Q. How may a passenger triple valve be distinguished?*

*A. By having but one exhaust outlet and a raised letter "P" cast on the body.*

*121c. Q. How may a freight triple valve be distinguished?*

*A. By its two exhaust outlets, one being plugged.*

*121d. Q. When should a Westinghouse freight triple valve graduating spring be replaced with a new one?*

*A. When it is found to be less than 3 inches in length.*

*121e. Q. When should a passenger triple valve spring be replaced with a new one?*

*A. When it is found to be less than 2¼ inches in length.*

E. W. Grieves,
Wm. Garstang,
James E. Simons,
E. D. Bronner,
*Committee of M. C. B. Ass'n.*

Godfrey W. Rhodes,
C. H. Cory,
A. M. Waitt,
A. W. Ball,
B. Haskell,
*Committee of A. R. M. M. Ass'n.*

The Air Brake and Signal Instructions, as revised, are as follows:

# AIR-BRAKE AND SIGNAL INSTRUCTIONS.

REVISED 1898.

## GENERAL INSTRUCTIONS.

The following rules and instructions are issued for the government of all employes of this railroad whose duties bring them in contact with the maintenance or operation of the automatic air brake and train air signal. They must be obeyed in all respects, as employes will be held responsible for the observance of the same, as strictly as for the performance of any other duty.

Every employe whose duties are connected in any way with the operation of the air brake, will be examined from time to time as to his qualification for such duties, by the Inspector of Air Brakes or other person appointed by the proper authority, and a record will be kept of such examination.

A book of information will be issued, in convenient form, giving a complete explanation of all parts of the air brake and train air signal equipment, with directions for the care and operation of the same. Any employe of this railroad whose duties require a knowledge of the operation and maintenance of the air brake and air signal will be furnished with a copy of the same upon application at place designated by special notice, and every employe will be held responsible for a full knowledge of his duties in the operation or maintenance of the air brake or signal equipment. If the directions contained in that book are observed, and the rules and instructions herewith are obeyed, no failure of the air brake or train air signal, at the time when it is needed, should occur. If such a failure does occur, it will be assumed that some employe has neglected his duty, and an investigation will be made to ascertain who is responsible for such failure.

## INSTRUCTIONS TO ENGINEMEN.

GENERAL.—Engineers, when taking their locomotives, must see that the air-brake apparatus on engine and tender is in good working order; that the air pump and lubricator work properly; that the regulator prevents the train-pipe pressure exceeding a maximum of seventy (70) pounds; that an excess pressure of not less than twenty pounds can be maintained in the main reservoir when the handle of the engineer's brake valve is placed in position 2 (Running Position); that the engineer's brake valve works properly in all different positions of the handle; and that, when the brakes are fully applied, the driver brake pistons do not travel less than ⅓ nor more than ⅔ of their stroke, and the tender brake piston does not travel less than six nor more than nine inches. They must also know that the air signal responds properly by opening the stop cock of the air signal train line.

Engineers must report to roundhouse foreman, at the end of the run, any defect in the air brake or signal apparatus.

MAKING UP TRAINS AND TESTING BRAKES.—The train pipe under the tender must always be blown out thoroughly before connecting to the train. Be sure to

THE ENGINEER'S BRAKE AND EQUALIZING VALVE AND DUPLEX AIR GAUGE.

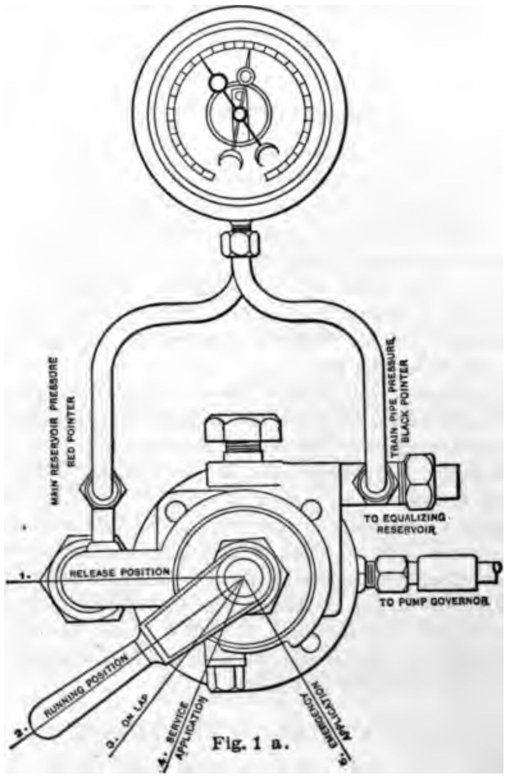



Fig. 1 a.

have not less than 90 pounds main reservoir pressure on the engine when connected to the train.

When the locomotive has been coupled to the train and it has been charged with an air pressure of 70 pounds, the engineer shall, at a signal from the inspector or trainman, apply the brakes with full service application of not less than 25 pounds reduction, and leave them so applied until the brakes on the entire train have been inspected and the signal is given to release. He shall then release the brakes, and shall not leave the station until it has been ascertained that all brakes are released and he has been informed by the inspector or trainmen. This test must be

made after each change in the make-up of the train, and before starting down such grades as may be designated by special instructions. Where the train air signal is used, the signal to release the brakes, in testing, will be given from the rear car of the train, to show that the signal connections have been properly made.

SERVICE APPLICATION.—In applying the brakes to steady the train upon descending grades, or for reducing the speed for any purpose, be very careful not to

THE ENGINEER'S BRAKE AND EQUALIZING VALVE AND DUPLEX AIR GAUGE.

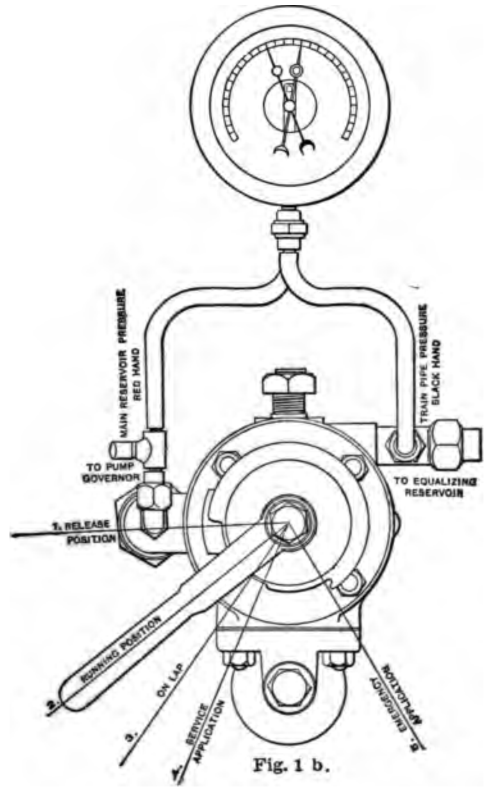


Fig. 1 b.

make too great a reduction of pressure in the outset, as the speed of the train will be too quickly or too much checked, and it will be necessary to release the brakes and apply them again later, perhaps repeating the operation. APPLY THE BRAKES LIGHTLY AT A SUFFICIENT DISTANCE FROM THE STOPPING POINT, AND INCREASE THE BRAKING FORCE GRADUALLY, AS IS FOUND NECESSARY, SO AS TO MAKE THE STOP WITH ONE APPLICATION, OR AT MOST TWO APPLICATIONS OF THE BRAKES.

With freight trains first allow the slack to run up against the locomotive. Great care must then be taken to apply the brakes with 5 to 7 pounds reduction and not make a second reduction until the effect of the first reduction is felt on entire train, in order to prevent shocks which otherwise may be serious.

In making a service stop with a passenger train, ALWAYS RELEASE THE BRAKES A SHORT DISTANCE BEFORE COMING TO A DEAD STOP, except on heavy grades, to prevent shocks at the instant of stopping. Even on moderate grades it is best to do

THE ANGLE COCK.

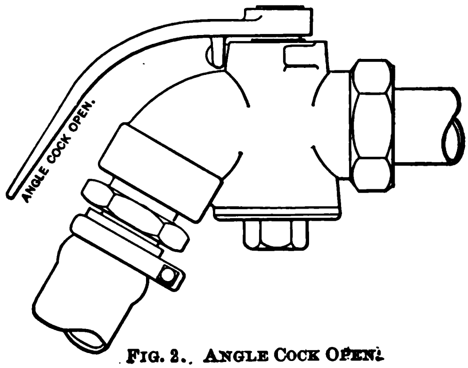



FIG. 2. ANGLE COCK OPEN.

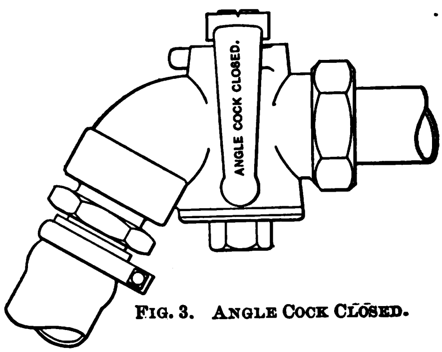



FIG. 3. ANGLE COCK CLOSED.

this, and then, after release, to apply the brakes lightly, to prevent the train starting, so that when ready to start the release will take place quickly. This does not apply to freight trains, upon which the brakes must not be released until the train has stopped.

EMERGENCY APPLICATIONS.— The emergency application of the brakes must not be used, except in actual emergencies.

BRAKES APPLIED FROM AN UNKNOWN CAUSE.— If it is found that the train is dragging at any time without a rapid fall of the black pointer, move the handle of the

engineer's valve into the full release position for a few seconds, and then return it to the running position.

If, however, the brakes go on suddenly, with a fall of the black pointer, it is evidence that (*a*) a conductor's valve has been opened, (*b*) a hose has burst or other serious leak has occurred, or (*c*) the train has parted.

In such an event, place the handle immediately in position 3, to prevent the escape of air from the main reservoir, and leave it there until the train has stopped, the brake apparatus has been examined and a signal to release is given.

THE PLAIN STRAIGHT-WAY COCK.

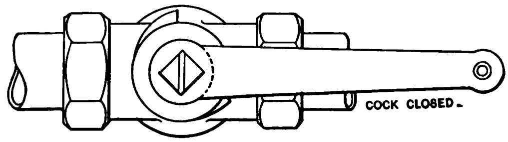



FIG. 4. COCK CLOSED.

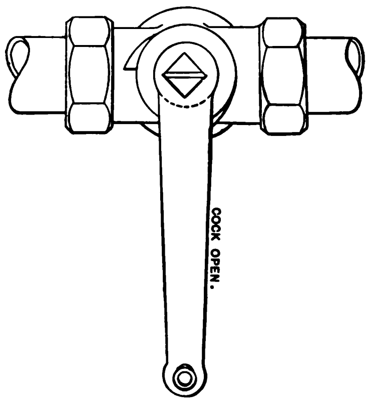



FIG. 5. COCK OPEN.

BRAKING BY HAND.— NEVER USE THE AIR BRAKE when it is known that the trainmen are operating the brakes of the air brake cars by hand, as there is danger of injury to the trainmen by so doing.

CUTTING OUT BRAKES.— THE DRIVER AND TENDER BRAKES MUST ALWAYS BE USED AUTOMATICALLY AT EVERY APPLICATION OF THE TRAIN BRAKES, unless defective — except upon such grades as shall be designated by special instructions.

When necessary to cut out either driver or tender brake, on account of defects, it shall be done by turning the handle of the four-way cock in the triple valve down to a position midway between a horizontal and a vertical position, first releasing the brake and leaving the bleed cock open. With the special driver brake triple valve, close the cut-out cock in the branch pipe.

DOUBLE HEADERS.— When two or more locomotives are coupled in the same train the brakes must be connected through to and operated from the head engine. For this purpose a cock is placed in the train pipe just below the engineer's valve. The engineer of each locomotive, except the head one, must close this cock and place the handle of the engineer's valve in position 2. He will start his air pump and let it run, as though he were going to use the brake, for the purpose of maintaining air

THE PLAIN AUTOMATIC TRIPLE VALVE.

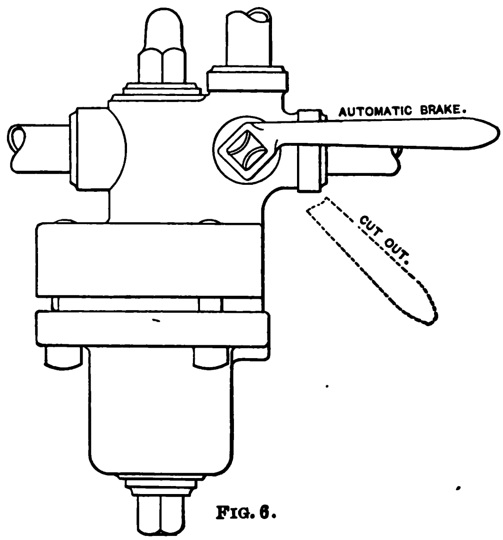



FIG. 6.

pressure on his locomotive and enabling him to assume charge of the train brakes should occasion require it.

AN EXTRA AIR-BRAKE HOSE COMPLETE must always be carried on the locomotive for repairs in case of a burst hose. Upon locomotives having the air signal a signal hose complete must also be carried for the same purpose.

## INSTRUCTIONS TO TRAINMEN.

MAKING UP TRAINS AND TESTING BRAKES.—When the locomotive has been coupled to the train, or when two sections have been coupled together, the brake and signal couplings must be united, the cocks in the train pipes — both brake and signal —must all be open, except those at the rear end of the last car, which must be closed, and the hose hung up properly in the dummy coupling, when cars are so equipped.

After the engineer has charged the train with air he must then be signaled to apply the brakes, as provided for in the train rules. When he has done so the brakes

of each car must be examined to see if they are properly applied. When it is ascertained that each brake is applied the engineer must be signaled to release the brakes. When the train air signal is to be used the signal to the engineer to release the brakes must be given by means of the air signal from the rear car of the train. The brakes of each car must then be examined to see that each is released.

If any defect is discovered it must be remedied and the brakes tested again — the operation being repeated until it is ascertained that everything is right. The conductor and engineer must then be notified that the brakes are all right. This examination must be made every time any change is made in the make-up of the train and before starting down such grades as may be designated by special instructions. At points where there are no inspectors trainmen must carry out these instructions. No passenger train must be started out from an inspection point with the

THE PRESSURE RETAINING VALVE.

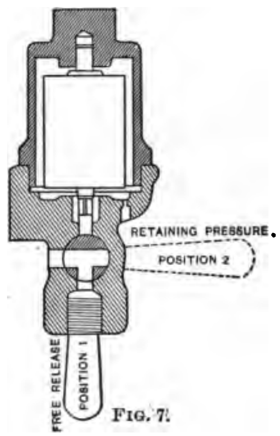


FIG. 7.

brakes upon any car cut out or in a defective condition without special orders from the proper officers. The air brakes must not be alone relied upon to control any freight train with a smaller proportion of cars with the air brake in service than provided for by special instructions. When hand brakes are also used they must be applied upon those cars next behind the air-braked cars.

DETACHING LOCOMOTIVE OR CARS.— First close the cocks in the train pipes at the point of separation, and then part the couplings, invariably by hand.

COUPLINGS FROZEN.— If the couplings are found to be frozen together or covered with an accumulation of ice, the ice must first be removed and then the couplings thawed out by a torch to prevent injury to the gaskets.

BRAKES STICKING.— If brakes are found sticking, the engineer must be signaled "brakes sticking," as provided for by special rules. If the engineer cannot release the brakes, or if the brakes are applied to detached cars, the release may

be effected by opening the bleed cock in the auxiliary reservoir until the air begins to release through the triple valve, when the reservoir cock must immediately be closed.

TRAIN BREAKING INTO TWO OR MORE PARTS.— First close the cock in the train pipe at the rear of the first section and signal the engineer to release the brakes. Having coupled to the second section, observe the rule for making up trains — first being sure that the cock in the train pipe at the rear of the second section has been closed, if the train has broken into more than two sections. When the engineer has released the brakes on the second section the same method must be employed with reference to the third section, and so on. When the train has been once more entirely united the brakes must be inspected on each car to see that each is released before proceeding.

CUTTING OUT THE BRAKE ON A CAR.— If, through any defect of the brake apparatus while on the road, it becomes necessary to cut out the brake upon any car, it may be done by closing the cock in the cross-over pipe near the center of the car where the quick-acting brake is used, or by turning the handle of the cock in the triple valve to a position midway between a horizontal and vertical where the plain automatic brake is used, first releasing the brake. When the brake has been thus cut out, the cock in the auxiliary reservoir must be opened and left open upon passenger cars, or held open until all the air has escaped from the reservoir upon freight cars. THE BRAKE MUST NEVER BE CUT OUT UPON ANY CAR UNLESS THE APPARATUS IS DEFECTIVE, and when it is necessary to cut out a brake the conductor must notify the engineer and also send in a report stating the reasons for so doing.

CONDUCTOR'S VALVE.— Should it become necessary to apply the brakes from the train, it may be done by opening the conductor's valve, placed in each passenger equipment car. THE VALVE MUST BE HELD OPEN UNTIL THE TRAIN COMES TO A FULL STOP, AND THEN MUST BE CLOSED AGAIN.

This method of stopping the train must not be used except in case of emergency.

BURST HOSE.— In the event of the bursting of a brake hose, it must be replaced and the brakes tested before proceeding, provided the train be in a safe place. If it is not, the train pipe cock immediately in front of the burst hose must be closed, and the engineer signaled to release. All the brakes to the rear of the burst hose must then be released by hand, and the train must then proceed to a safe place where the burst hose must be replaced and the brakes again connected and tested as in making up a train. One extra air brake hose complete should be carried by all crews and one extra signal hose complete carried by passenger crews for repairs.

BRAKES NOT IN USE.— When the air brakes are not in use, either upon the road or in switching, the hose must be kept coupled between the cars or hung up properly to the dummy couplings, when cars are so equipped.

PRESSURE-RETAINING VALVE.— When this valve is to be used, the trainmen must, at the top of the grade, test the brakes upon the whole train, and must then pass over the train and turn the handles of the pressure-retaining valves horizontally (position 2) upon all or a part of the cars, as may be directed. At the foot of the grade, the handles must all be turned downward again (position 1). Special instructions will be issued as to the grades upon which these valves are to be used.

TRAIN AIR SIGNAL.— In making up trains, all couplings and car discharge

valves on the cars must be examined to see if they are tight. Should the car discharge valve upon any car be found to be defective while on the road, it may be cut out of use upon that car by closing the cock in the branch pipe leading to the valve. The conductor must always be immediately notified when the signal has been cut out upon any car, and he must report the same for repairs.

In using the signal, pull directly down upon the cord during one full second, for each intended blast of the signal whistle, and allow two seconds to elapse between the pulls.

Reporting Defects to Inspectors.— Any defect in either the air brake or air signal apparatus discovered upon the road must be reported to the inspector at the end of the run; or, if the defect be a serious one in passenger service, it must be reported to the nearest inspector, and it must be remedied before the car is again placed in service.

## INSTRUCTIONS TO ENGINE-HOUSE FOREMEN.

General.— It is the duty of engine-house foremen to see that the air brake and signal equipment is properly inspected upon each locomotive after each run. It must be ascertained that all pipe joints, connections and all other parts of the apparatus are air tight, duplex gauges tested every thirty days, and that the apparatus is in good working order.

Air Pump.— The air pump must be tested under pressure, and if found to be working imperfectly in any respect, it must be put into thoroughly serviceable condition.

Pump Governor.— The pump governor should cut off the steam supply to the pump, when the train pipe pressure has reached seventy (70) pounds, with D 8 brake valve, and at 90 pounds main reservoir pressure with E 6 or F 6 valve. If it does not, it must be regulated to do so.

Engineer's Brake Valve.— This valve must be kept clean and in perfect order. With the handle in position 2, the main reservoir pressure must not be less than twenty pounds greater than train pipe pressure. The valve must be tested with the handle in positions 4 and 3, to note that the equalizing piston responds promptly, and that there are no leaks from port to port under the rotary disk valve.

Adjustment of Brakes.— The driver brakes must be so adjusted that the pistons travel not less than one-third nor more than two-thirds of their stroke. When the cam brake is used care must be taken to adjust both cams alike, so that the point of contact of the cams shall be in line with the piston rod. The tender brake must be adjusted by means of the dead truck levers, so that the piston travels not less than six inches when the air brake is applied and the hand brake is released. This adjustment must be made whenever the piston travel is found to exceed nine inches.

Brake Cylinders and Triple Valves.— These must be examined and cleaned once every six months, and the cylinders oiled once in three months. If the driver brake cylinders are in a position to be affected by the heat of the boiler, they must be oiled more frequently. A record must be kept of the dates of last cleaning and oiling for each locomotive.

Draining.— The main reservoir, and also the drain cup in the train pipe under the tender must be drained of any accumulation after each trip. The auxiliary reservoirs and triple valves must also be drained frequently, and daily in cold weather, and the train pipe under the engine and tender blown out.

Air Signal.— The train air signal apparatus must be examined and tested by suitable appliances from both the head of the engine and the rear of the tender, to know that the whistle responds properly. A pressure gauge must be applied to the air signal pipe, once each month, to ascertain that the reducing valve maintains the proper pressure of forty pounds per square inch in the train signal pipe.

## INSTRUCTIONS TO INSPECTORS.

General.— It is the duty of all inspectors to see that the couplings, the pipe joints, the triple valves, the conductor's valves, the air signal valves, and all other parts of the brake and signal apparatus are in good order and free from leaks. For this purpose they must be tested under the full air pressure as used in service. No passenger train must be allowed to leave a terminal station with the brake upon any car cut out, or in a defective condition, without special orders from the proper officer.

If a defect is discovered in the brake apparatus of a freight car, which cannot be held long enough to give time to correct such defect, the brake must be cut out and the car properly carded, to call the attention of the next inspector to the repairs required.

Special rules will specify the smallest proportion of freight cars, with the air brakes in good condition, which may be used in operating the train as an air brake train.

Making Up Trains and Testing Brakes.— In making up trains, the couplings must be united and the cocks at the ends of the cars all opened, except at the rear end of the last car, where the cocks must be closed, the inspector must know that the air is passing through the pipes to the rear end, and the couplings properly hung up to the dummy couplings, if so equipped. After the train is fully charged, the engineer must be signaled to apply the brakes. When the brakes have been applied, they must be examined upon each car to see that they are applied with proper piston travel. This having been ascertained, the inspector must signal the engineer to release the brakes, using the train air signal from the rear car, upon passenger trains. He must then again examine the brakes upon each car to note that each is released. If any defect is discovered, it must be corrected and the testing of the brakes repeated, until they are found to work properly. The inspector must then inform both the engineer and conductor of the number of cars with brakes in good order.

This examination must be repeated if any change is made in the make-up of the train before starting.

Cleaning Cylinders and Triple Valves.— The brake cylinders and triple valves must be kept clean and free from gum. They must be cleaned and oiled as often as once in six months, upon passenger cars, and once in twelve months upon freight cars. The dates of last cleaning and oiling must be marked with white paint upon the cylinder in the places left for such dates opposite the words, which will be

stenciled with white paint, in one-inch letters, upon the cylinder or reservoir as follows:

Cylinder cleaned and oiled ..........................................

Triple cleaned and oiled ..........................................

The triple valves and auxiliary reservoirs must be frequently drained, especially in cold weather, by removing the plug in the bottom of the triple valve and opening the bleed cock in the reservoir.

GRADUATING SPRINGS.—The graduating springs in the Westinghouse quick-action freight triple valves are No. 15 B. W. G. brass wire, 14 coils, 3 inches free height after taking permanent set; and in passenger No. 14 B. W. G., 12 coils, 2½ inches free height after receiving permanent set.

ADJUSTMENT OF BRAKES.—The slack of the brake shoes must be taken up by means of the dead truck levers.

In taking up such slack, it must be first ascertained that the hand brakes are off, and the slack is all taken out of the upper connections, so that the truck levers do not go back within 1 inch of the truck timber or other stop, when the piston of the brake cylinder is fully back at the release position. When, under a full application, the brake piston travel is found to exceed nine inches upon passenger or freight cars, the brake shoe slack must be taken up and the adjustment so made that the piston shall travel not less than six inches. In taking up the brake shoe slack it must never be taken up by hand brakes.

BRAKING POWER.—Where the cylinder lever has more than one hole at the outer end the different holes are for use upon cars of different weights.

It must be carefully ascertained that the rods are connected to the proper holes, so that the correct braking power shall be exerted upon each car.

REPAIR PARTS.—Inspectors must keep constantly on hand for repairs a supply of all parts of the brake and signal equipment that are liable to get out of order.

HANGING UP HOSE.—Inspectors must see that, when cars are being switched or standing in the yard, the hose is coupled between the cars or properly secured in the dummy coupling, when cars are so equipped.

RESPONSIBILITY OF INSPECTORS.—Inspectors will be held strictly responsible for the good condition of all the brake and signal apparatus upon cars placed in trains at their stations; they will also make any examination of brake apparatus or repairs to the same, which they may be called upon to do by trainmen.

# GENERAL QUESTIONS

REGARDING THE USE OF THE

# AIR BRAKE AND TRAIN SIGNAL.

## GENERAL QUESTIONS.

(All parties who have to do with the use, adjustment, care or repairs of air brakes should be thoroughly examined on these questions, in addition to the special questions for each class of men following them.)

1. Question. What is an air brake?

Answer. It is a brake applied by compressed air.

2. Q. How is the air compressed?

A. By an air pump on the locomotive.

3. Q. How does the compressed air apply the brakes?

A. It is admitted into a brake cylinder on each car, and it pushes out a piston in that cylinder which pulls the brake on.

4. Q. How does the piston get back when the brakes are released?

A. There is a spring around the piston rod which is compressed when the brakes are applied, and when the air is allowed to escape to release the brakes, this spring reacts and pushes the piston in again.

5. Q. Where is the compressed air kept ready for use in the automatic air brake?

A. In the main reservoir on the locomotive, in the smaller or auxiliary reservoir on each car, and in the train pipe.

6. Q. Where does the compressed air come from directly, that enters the brake cylinder when the automatic brake is applied?

A. It comes from the auxiliary reservoir on each car in service application, and from the auxiliary reservoir and train pipe in emergency application.

7. Q. How does it get into the auxiliary reservoir?

A. It is furnished from the main reservoir on the locomotive through the train pipe and triple valve when the brakes are released.

8. Q. How is the automatic brake applied and released?

A. The automatic brake is applied by reducing the air pressure in the train pipe below that in the auxiliary reservoir, and is released by raising the train pipe pressure above that remaining in the auxiliary reservoir.

9. Q. Why does the compressed air not enter directly into the brake cylinder from the train pipe?

A. Because the triple valve used with the automatic brake prevents the air from entering directly from the train pipe to the brake cylinder when the pressure in the train pipe is maintained or increased.

10. Q. What other uses has the triple valve?

A. It causes the brake cylinder to be opened to the atmosphere under each car, to release the brakes when the pressure in the train pipe is made greater than that

in the auxiliary reservoir, and it opens communication from the train pipe to the auxiliary reservoir by the same movement; when the pressure in the train pipe is reduced, it closes the openings from the train pipe to the auxiliary reservoir and from the brake cylinder to the atmosphere, and then opens the passage between the auxiliary reservoir and the brake cylinder by the same movement, so as to admit the air and apply the brakes.

11. Q. How many forms of triple valves are there in use, and what are they called?

A. Two: the plain triple and the quick-acting triple.

12. Q. How can you tell the plain triple from the quick-acting triple?

A. The plain triple has a four-way cock in it, with a handle for operating the cock; the quick-acting triple has no such cock in it, but there is a plug cock in the cross-over pipe leading from the train pipe to the triple, when the quick-acting triple is used.

13. Q. What are these cocks for in both cases?

A. They are to be used to cut out brakes on one car, without interfering with other brakes on the train, if the brake on that car has become disabled.

14. Q. How does the cock handle stand in the plain triple valve when the pipe is open for automatic action?

A. It stands in a horizontal position.

15. Q. In what position does the same handle stand when the brakes are cut out by closing the cock?

A. It stands at an inclined position midway between horizontal and vertical.

16. Q. How does the handle of the plug cock in the cross-over pipe, used with the quick-acting triple, stand for automatic action?

A. It stands with the handle crosswise with the pipe, and the cock is then open.

17. Q. How does it stand when the cock is closed and the brake cut out of action?

A. It stands with handle lengthwise of cross-over pipe.

18. Q. How is the train pipe coupled up between the cars?

A. By means of a rubber hose on each end of the train pipe, fitted with a coupling at the loose end.

19. Q. How is the train pipe closed at the rear end of the train?

A. By closing the cock in the train pipe at the rear end of the last car.

20. Q. How many such train pipe cocks are there to a car, on the air brake train pipe and on the air signal train pipe, and why?

A. Two for each pipe on each car, because either end of any car may sometimes be at the rear end of the train.

21. Q. How many kinds of train pipe cocks are there in use at the ends of the cars?

A. Two.

22. Q. Describe each and give the position of the handles for open and closed in each case?

A. The older form of train pipe cock is a straight plug cock in the train pipe, not far from the hose connection; the handle stands crosswise with the pipe when it is open, and lengthwise with the pipe when closed; it is now found principally on the air signal pipe. The other form of train pipe cock now used on the air-brake

pipe is an angle cock placed at the end of the train pipe and close to the hose. The handle of the angle cock stands lengthwise with the pipe when open, and crosswise with the pipe when closed.

23. Q. What uses have these train pipe cocks besides to close the pipe at the rear end of the train?

A. They are to be used to close the train pipe at both sides of any hose coupling which is to be parted, as when the train is cut in two.

24. Q. Why is it necessary to close the train pipe on both sides of the hose coupling before it is parted?

A. To prevent the escape of air from the train pipe which would apply the brakes.

25. Q. How must the hose coupling be parted when it is necessary to do so, and why?

A. The air-brake must first be released on the train from the engine, then the adjacent train pipe cocks must both be closed and the coupling must be parted by hand, to prevent the possibility of injury to the rubber gasket in the coupling.

26. Q. Why must the brakes be fully released before uncoupling the hose between the cars?

A. Because if the brakes are applied upon a detached car, they cannot be released without bleeding the auxiliary reservoir, and thus wasting air.

27. Q. In coupling or uncoupling the hose between cars, what must be done if there is ice on the couplings?

A. The ice must first be removed and the couplings thawed out, so as to prevent injury to the rubber gaskets in uncoupling, and to insure tight joints in coupling the hose.

28. Q. What must be done with a hose coupling which is not coupled up, such as the rear hose of a train, or any hose on a car which is standing or running, but not in use?

A. It must be placed in the dummy coupling if provided for in such manner that the flat pad on the dummy will close the opening in the coupling.

29. Q. What pressure should be carried in the train pipe and auxiliary reservoir?

A. Seventy pounds pressure to the square inch.

30. Q. Why should this pressure be 70 pounds?

A. Because this pressure is necessary, to get the full braking force which each car is capable of using, and, if it be exceeded, there will be danger of sliding the wheels.

31. Q. How much pressure can be obtained in the brake cylinder by the service application of the brakes with 70 pounds in the auxiliary reservoir.

A. About 50 pounds pressure to the square inch, with an eight-inch piston travel.

32. Q. Why can only 50 pounds pressure be obtained under these circumstances?

A. Because the air, at 70 pounds pressure in the auxiliary reservoir, expands into an additional space when the auxiliary reservoir is opened to the brake cylinder, and, when the pressure has become equalized, it is thus reduced to 50 pounds.

33. Q. How much must the train pipe pressure be reduced, in order to get 50 pounds pressure in the brake cylinder, in ordinary service?

A. Twenty pounds; or from 70 pounds down to 50 pounds in the train pipe also.

34. Q. Can the brakes be applied so as to get only a portion of this 50 pounds pressure in the brake cylinder, and how?

A. They can be so applied by reducing the train pipe pressure less than 20 pounds.

35. Q. If the train pipe pressure be reduced 10 pounds what will the pressure be in the brake cylinder?

A. About 25 pounds.

36. Q. How is this graduated action obtained?

A. By means of the graduating valve in the triple valve.

37. Q. Is it important to keep all the air-brake apparatus tight and free from leaks?

A. Yes.

38. Q. Why is this important?

A. In order to get full service from the air brakes, and to prevent the waste of air, and also to prevent the brakes applying automatically by reason of leak in the train pipe.

39. Q. Is it important to know that the train pipe is open throughout the train and closed at the rear end before starting out?

A. Yes; this is very important.

40. Q. Why is this very important?

A. Because if any cock in the train pipe were closed, all the brakes back of the cock which is closed would be prevented from working.

41. Q. How can you know that the train pipe cocks are all open when the train is made up?

A. By testing the brakes; that is, by applying and releasing them, and observing whether they all operate.

42. Q. Do you understand that no excuse will be acceptable for starting out the train without first testing the air brakes?

A. Yes.

43. Q. Why is this rule absolute?

A. Because the safety of passengers and of property depends upon the brakes being properly coupled up and in an operating condition before the train is started.

44. Q. At what other times should the brakes be tested, and how?

A. After each change in the make-up of the train and before starting the train down certain designated grades, and the test should be made with a full service application of the brakes.

45. Q. From where does the air signal apparatus receive its pressure?

A. From the main air reservoir through the reducing valve.

46. Q. How much air pressure should be carried in the air-signal train pipe?

A. Forty pounds pressure.

47. Q. Is it important that this train pipe and its connections be also kept tight?

A. Yes.

48. Q. After taking up the slack of the brake shoes, how far should the brake piston travel in the cylinders on cars and tenders with a full application of the brake?

A. Not less than 6 inches.

49. Q. What would happen if the piston traveled less than 6 inches when brakes are fully applied?

A. A partial application of the brakes might not close the leakage groove in the brake cylinder provided for the escape of small amounts of air.

50. Q. Why should the piston travel not be permitted to exceed nine inches on passenger cars, tenders, or freight cars?

A. Because, if it travels farther than this when sent out, a little wear of the brake shoes will cause the piston to travel far enough to rest against the back cylinder head when the brakes are applied, and this cylinder head would then take the pressure instead of its being brought upon the brake shoes.

51. Q. How far should the driver brake piston travel with a full application of the brakes, and why?

A. Not less than one-third of the full stroke of the piston nor more than two-thirds of its full stroke, for reasons similar to those given for cars and tenders.

52. Q. If the brakes stick upon any car so that the engineman cannot release them at any time, how should they be released?

A. By opening the release cock in the auxiliary reservoir and holding it open until air begins to escape from the triple valve and then closing it again.

53. Q. What is the pressure-retaining valve, and what is its use?

A. The pressure-retaining valve is a small valve placed at the end of a pipe from the triple valve, through which the exhaust takes place from the brake cylinder. It is used to retard the brake release on heavy grades, and hold the brakes partially applied, so as to allow more time for the engineman to recharge the auxiliary reservoir.

54. Q. What precautions are necessary on every train in regard to hose couplings?

A. Every train must carry at least two extra hose and couplings complete, for use in replacing any hose couplings which may fail or become disabled. These extra hose and couplings to be carried on such part of the train as is required by the rules and regulations.

## SPECIAL FOR ENGINEMEN.

55. Q. How should the air pump be started?

A. It should be started slowly, so as to allow the condensation to escape from the steam cylinder and prevent pounding, which is more likely to occur when the air pressure is low.

56. Q. Why should the piston rod on the air pump be kept thoroughly packed?

A. To prevent the waste of air and steam.

57. Q. How should the steam cylinder of the air pump be oiled, and what kind of oil should be used?

A. It should be oiled as little as necessary through a sight feed lubricator, and cylinder oil should be used.

58 Q How should the air cylinder of the air pump be oiled; what kind of oil, and why?

A. It should be oiled very little by once filling the oil-cup with a good quality of well oil daily. Cylinder oil, lard oil and other animal or vegetable oils should not be used, as their use causes the engineer's brake valve and the triple valves to gum up. The oil must never be introduced through the air inlet ports, as this practice would cause the pump valves to gum up.

59. Q. What regulates the train pipe pressure?

A. The pump governor, with D 8 valve, and the feed valve attachment with the E 6 or F 6 valve.

60. Q. Why should the train pipe pressure not exceed 70 pounds?

A. Because 70 pounds train pipe pressure produces the strongest safe pressure of the brake shoes upon the wheels. A higher train pipe pressure is liable to cause the wheels to slide.

61. Q. Why is an equalizing engineer's valve better than the older forms?

A. Because it enables the engineer to apply the brakes more uniformly throughout the train, and with less shock to the train, especially when the quick-acting triple valves are used. It also prevents the brakes from being kicked off on the forward end of the train when the engineer closes the valve after applying the brakes.

62. Q. Why does an equalizing engineer's valve produce these results in ordinary service stops?

A. Because the engineer does not, in such cases, open the train pipe to the atmosphere direct, but he only reduces the air pressure above the piston in the engineer's valve, which causes that piston to open the train pipe to the atmosphere, and to close the opening gradually when the train pipe pressure has been correspondingly reduced.

63. Q. What does the excess pressure valve in the D 8 brake valve accomplish, and do you regard it important to have it working properly?

A. It maintains an excess pressure in the main reservoir above the pressure in the train pipe, and it is important that it be kept clean and in working order so as to have this excess pressure to insure release, and for use in recharging the train quickly after the brakes are released.

64. Q. What does the feed valve attachment of the E 6 or F 6 engineer's valve accomplish?

A. When properly adjusted it restricts the train pipe pressure to a maximum of 70 pounds with the engineer's valve in running position. When this valve is used, the pump governor is attached to main reservoir pressure and may be set to carry whatever pressure is desired therein.

65. Q. How often should the brake valve be thoroughly cleaned and oiled?

A. At least once every two months.

66. Q. If the rotary disk valve in the engineer's valve is unseated by dirt or by wear, what may be the result, and what should be done?

A. It may be impossible to get the excess pressure; when the brakes have been applied they may keep applying harder until full on, or when they have been applied they may go off. The rotary disk valve should be thoroughly cleaned, and if worn it should be faced and ground to a seat.

67. Q. If the piston in the engineer's valve becomes gummed up or corroded from neglect to clean it, what will be the result?

A. It will be necessary to make a large reduction of pressure through the preliminary exhaust port before the brakes will apply at all, and then the brakes will go on too hard, and will have to be released.

68. Q. When the locomotive is standing alone and the pump is running, why must the D 8 engineer's valve not be left standing in the lap position (No. 3)?

A. Because the main reservoir pressure may become so high that, when the handle of the engineer's valve is again placed in the release position, it will cause the train pipe and tender auxiliary reservoir to be charged with too high pressure, which might injure the adjustment of the pump governor as well as cause the tender wheels to be slid with the first application of the brakes.

69. Q. How and why should the train pipe under the tender always be blown out thoroughly before connecting up to the train?

A. By opening the angle cock at the rear end of the tender and allowing the air from the main reservoir to blow through. This blows out the oil, water, scale, etc., which may accumulate in the pipe, and which would be blown back into the train pipe and triple valves if not removed before coupling to the train.

70. Q. When the engine is coupled to the train, why is it necessary to have 90 pounds or more pressure in the main reservoir?

A. So that the brakes will all be released and the train quickly charged when the engineer's valve is placed in the release position.

71. Q. Why should the driver brakes always be operated automatically with the train brake?

A. Because it adds greatly to the braking force of the train, and the brakes can be applied alike to all the wheels for ordinary stops, and in an emergency the greatest possible braking force is at once obtained by one movement of the handle.

72. Q. In making a service application of the brakes, how much reduction of the train pipe pressure from 70 pounds does it require to get the brakes full on?

A. About 25 pounds reduction.

73. Q. What should the first reduction be in such an application, and why?

A. From five to seven pounds, so as to insure moving the pistons in the brake cylinders past the leakage groove, yet not apply the brakes too hard, until the slack in drawbars and drawsprings is first taken up.

74. Q. What is the result of making a greater reduction of pressure than 25 pounds?

A. A waste of air in the train pipe, without getting any more braking force, and therefore requiring more air to release the brakes.

75. Q. How many applications of the brakes are necessary in making a stop?

A. Generally only one; by applying them lightly at first with five to seven pounds reduction of air in the train pipe, and afterward gradually increasing the force of the application. Two applications are as many as should ever be required.

76. Q. Why is it dangerous to apply and release the brakes repeatedly in making stops?

A. Because every time the brakes are released the air in the brake cylinders is thrown away, and if it is necessary to apply them again before sufficient time has elapsed to recharge the auxiliary reservoirs the application of the brakes will be weak,

and after a few such applications the brakes are almost useless on account of the air having been exhausted from the auxiliary reservoirs.

77. Q. In releasing and recharging the train, how long should the handle of the engineer's valve be left in the release position?

A. Until the train pipe pressure has risen nearly to 70 pounds again.

78. Q. In making service stops with passenger trains, why should you release the brakes a little before coming to a full stop?

A. So as to prevent stopping with a lurch; it also requires less time for the full release of the brakes after stopping.

79. Q. In making stops with freight trains, why should the brakes not be released until after the train has come to a full stop?

A. Because long freight trains are apt to be parted by releasing the brakes at low speed.

80. Q. In making service stops, why must the handle of the engineer's valve not be moved past the position for service applications?

A. So as to prevent unnecessary jerks to the train, and the emergency action of the triple valve when not necessary.

81. Q. If you find the train dragging from the failure of the brakes to release, how can you release them?

A. By placing the handle on the engineer's valve in full release position, No. 1, for a few seconds, and returning it to the running position, No. 2.

82. Q. When the brakes go on suddenly when not operated by the engineer's valve, and the gauge pointer falls back, what is the cause, and what should you do?

A. Either a hose has burst, or a conductor's valve has been opened, or the train has parted. In any event, the handle of the engineer's valve must be immediately placed in the lap position to prevent the escape of air from the reservoir.

83. Q. Are the brakes liable to stick on after an emergency application, and why?

A. The brakes are harder to release after a severe application, because they are on with full force, and it requires higher pressure than usual in the train pipe to release them again. In this case it is necessary always to have in reserve the excess pressure on the main reservoir to aid in releasing the brakes. With the quick-acting triple valve this is especially necessary, because air from the train pipe as well as from the auxiliary reservoir is forced into the brake cylinder when a quick application of the brake is made, thus increasing the pressure in the brake cylinder without the usual reduction of pressure in the auxiliary reservoir, and requiring a high pressure in the train pipe afterward to cause the brakes to be released.

84. Q. In using the brakes to steady the train while descending grades, why should the air pump throttle be kept well open?

A. So that the pump may quickly accumulate a full pressure in the main reservoir for use in recharging the train when the brakes have been released again.

85. Q. In descending a grade how can you best keep the train under control?

A. First, by commencing the application of the brakes early, so as to prevent too high a speed being reached. Second, by applying the brakes lightly at first, then increasing the brake pressure as needed, and by slowing the train down just before it is necessary to release the brakes for recharging, so as to give time enough to refill the auxiliary reservoirs before much speed is again attained.

86. Q. If the train is being drawn by two or more locomotives, upon which engine should the brakes be controlled, and what must the enginemen of the other locomotive do?

A. The brakes must be controlled by the leading locomotive, and the enginemen of the following locomotives must close the cock in the train pipe just below the engineer's valves. The latter must always keep his pump running and in order, and main reservoir charged, with the engineer's valve in the running position, so that he may quickly operate the brakes if called upon to do so.

87. Q. If the air signal whistle only gives a weak blast, what is the probable cause?

A. Either the reducing valve is out of order so that the pressure is less than 40 pounds or the whistle itself is filled with dirt or not properly adjusted or the port under the end of signal valve is partially closed by gum or dirt.

88. Q. If the reducing valve for the air signal is allowed to become clogged up with dirt, what will the result probably be?

A. The signal pipe might get the full main reservoir pressure, and the whistle will blow when the brakes are released.

89. Q. If you discover any defect in the air brake or signal apparatus while on the road, what must be done?

A. If it is something that cannot be readily remedied at once, it must be reported to the engine-house foreman as soon as the run is completed.

90. Q. What is the result if water be allowed to collect in the main reservoir of the brake apparatus?

A. The room taken up by the water reduces the capacity for holding air, and the brakes are more liable to stick. In cold weather also the water may freeze and prevent the brakes from working properly.

## SPECIAL FOR ENGINE REPAIRMEN.

91. Q. How often must the air brake and signal apparatus on locomotive be examined?

A. After each trip.

92. Q. Under what pressure must it be examined?

A. Under full pressure, i. e., 70 pounds on the air brake train pipe, 20 pounds excess in the main reservoir, and 40 pounds pressure upon the air signal train pipe.

93. Q. How will you be sure that proper pressures are upon the two train pipes?

A. By regulating, and, if necessary, cleaning the pump governor so that it will shut off steam from the pump when 70 pounds train pipe pressure is reached, and by examining, and, if necessary, cleaning the pressure reducing valve for the signal train pipe, so that it maintains 40 pounds pressure in the train pipe.

94. Q. If you do not obtain 20 pounds excess pressure in the main reservoir when the handle of the D 8 engineer's valve is in the running position, what is the cause?

A. Either the excess pressure valve needs cleaning, or the rotary disk valve in the engineer's valve is unseated and allows air to leak from one port to another.

95. Q. Should the train pipe pressure exceed the maximum of 70 pounds, where would you look for the cause of the trouble in the Westinghouse F 6 brake valve?

A. Either the supply valve needs cleaning, the rotary disk valve is unseated, or the gasket between the main reservoir connection and chamber D is defective; or the feed valve attachment case gasket is defective; or the regulating spring below the piston needs adjusting.

96. Q. Why must the air pump piston rod be kept well packed?

A. To prevent leakage of steam and air.

97. Q. How often must the main reservoir and the drain cup under the tender be drained?

A. After each trip.

98. Q. How often must the triple valves and the cylinders of the driver and tender brakes be cleaned and oiled?

A. They must be thoroughly cleaned and oiled with a small amount of mineral oil once every six months, and the cylinders must be oiled every three months. If the driving brake cylinders are so located that they become hot from the boiler, they may require oiling more frequently.

99. Q. If there are any leaks in the pipe joints or anywhere in the apparatus, what must you do?

A. Repair them before the locomotive goes out.

100. Q. How is the brake shoe slack of the cam driver brake taken up, and what precautions are necessary?

A. By means of the cam screws, and it is necessary to lengthen both alike, so that when the brake is applied the point of contact of the cams will be in a line with the piston rod.

101. Q. How is the brake shoe slack of driver brakes on a locomotive with more than two pairs of driving wheels taken up?

A. By means of a turn-buckle or screw in the connecting rods.

102. Q. How is the slack of the tender brake shoes taken up?

A. By means of the dead truck levers; if they will not take it up enough, it must be taken up in the underneath connection, and then adjusted by the dead lever.

103. Q. How far should the driver brake piston travel in applying the brakes?

A. Not less than one-third nor more than two-thirds of the full stroke of the piston.

104. Q. What travel of piston should the tender brakes be adjusted for?

A. Not less than five inches nor more than six inches, and such adjustment must be made whenever the piston travel is found to exceed eight inches.

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## SPECIAL FOR TRAINMEN.

105. Q. How should you proceed to test the air brakes before starting out, after a change in the make-up of a train, or before descending certain specially designated grades?

A. After the train has been fully charged with air, the engineman must be signaled to apply the brakes; when he has done so, the brakes must be examined upon

each car to see that the air is applied and that the piston travel is not less than five inches nor more than eight inches, on a passenger car, or nine inches on a freight car. The engineman must be then signaled to release the brakes, and this signal must be given by the train air signal from the rear car, if it is in use upon the train; after he has done so, each brake must be examined again to see that all are released. The engineman and conductor must then be notified that the brakes are all right, if they are found so.

106. Q. In starting out a passenger train from an inspection point, how many cars must have the brakes in service?

A. Every car upon the train.

107. Q. When might you cut out a brake upon a passenger car?

A. Never; unless it gets out of order while on the run, in which case it must be reported to the inspector at the end of the run, or upon the first opportunity which may give sufficient time to repair it.

108. Q. If a hose bursts upon the run what must be done, if the train is in a safe place?

A. The hose must first be replaced by a good one, and the engineman then signaled to release the brakes. The train must not proceed until the brakes have been reconnected and tested upon the train to see that all are working properly.

109. Q. If the train is not in a safe place when the hose bursts, what must be done?

A. The train pipe cock immediately ahead of the burst hose must be closed and the engineer signaled to release the brakes. The brakes at the rear of the burst hose must then be released by bleeding the auxiliary reservoirs, and the train must then proceed to a safe place to replace the hose and connect up the brakes, after which the brakes must be tested.

110. Q. If the train breaks in two, what must be done?

A. The cock in the train pipe at the rear end of the first section must be closed, and the engineman signaled to release the brakes. The two parts of the train must then be coupled, the hose connected and the brakes again released by the engineman. When it is ascertained that the brakes are all released, the train may proceed.

111. Q. Explain how the pressure-retaining valves are thrown into action or thrown out of action, and when this must be done.

A. The pressure-retaining valve is thrown into action by turning the handle of the valve to a horizontal position, and it is thrown out of action again by placing this handle in a vertical position pointing downward. This handle should be placed in a horizontal position at the top of a heavy grade, and it should always be returned to a vertical position at the foot of the grade, as otherwise the brakes will drag on any cars which still have the handle of the pressure-retaining valve in the horizontal position.

112. Q. If the brake of any car is found to be defective on the run, how should you proceed to cut it out?

A. By closing the cock in the cross-over pipe of the quick-acting brake, or in the triple valve of the plain automatic brake, and then opening the release cock in the auxiliary reservoir upon that car, leaving it open, if a passenger car, or holding it open until all the air has escaped from it, if a freight car.

113. Q. When it is necessary to cut out a defective brake upon a car, why should it always be cut out at the triple valve and never by the train pipe cock at the end of the car, even if it is the last car of the train?

A. The train pipe should always be open from the locomotive to the rear end of the last car, so that if the train breaks in two the brakes will be automatically applied before the parts of the train have separated sufficiently to permit damage to be done by their coming together again, and so that the brakes may be applied with the conductor's valve upon any car.

114. Q. Should the train pipe burst under any car, what must be done?

A. The train must proceed to the nearest switching point, using the brakes upon the cars ahead of the one with the burst pipe, where the car with the burst pipe must be switched to the rear of the train; the hose must then be coupled up to the rear car and the cock at the rear end of the next to the last car opened and the cock at the forward end of the last car closed, so that if the train should part between the last two cars the brakes will be applied.

115. Q. What is the conductor's valve, and what is its use?

A. It is a valve at the end of the branch pipe leading from the train brake pipe upon each passenger car; it is to be opened from the car in any emergency when it is necessary to stop the train quickly, and only then. When used it should be held open until the train is stopped, and then it should be closed.

116. Q. What is the air signal for, and how is it operated?

A. It is to signal the engineman, in place of the old gong signal, and it is operated by pulling directly downward on the cord, and releasing immediately, allowing two full seconds to elapse between pulls.

117. Q. If the car discharge valve on the air signal system is out of order or leaking on any car, how can you cut it out?

A. By closing the cock in the branch pipe leading from the train signal pipe to the discharge valve; to do so the handle of this cock should be placed lengthwise with the pipe.

118. Q. How is the slack taken up so as to secure the proper adjustment of piston travel?

A. By means of the dead truck lever, and if that is not sufficient, one or more holes must be taken up in the underneath connection and the adjustment then made by the dead truck lever.

## SPECIAL FOR INSPECTORS.

119. Q. Do you understand that no passenger train may be started out with any of the brakes cut out of service?

A. I do.

120. Q. Why is it important that no leaks should exist in the air brake service?

A. Because they would interfere with the proper working of the brakes and might cause serious damage.

121. Q. What must be done with the air brake or air signal couplings when not united to other couplings, on cars equipped with dummy couplings?

A. They must be secured in the dummy coupling, so that the face of the dummy coupling will cover the opening of the hose coupling so as to prevent dust and dirt from entering the hose.

122. Q. If air issues from the release port of the quick-action triple valve when the brakes are off, what is the cause?

A. It is probably due to dirt on the rubber-seated emergency valve.

123. Q. How often must the cylinder and triple valves be examined, cleaned and oiled?

A. As often as once every six months on passenger cars and once in twelve months on freight cars, and the cylinders must be oiled once every three months with a small quantity of mineral oil. The dates of the last cleaning and oiling must be marked with white paint on the cylinders.

124. Q. What is the difference between the Westinghouse quick-action passenger and freight triple valve?

A. The passenger triple valves have larger ports and slide valves.

125. Q. How may a passenger triple valve be distinguished?

A. By having but one exhaust outlet and a raised letter "P" cast on the body.

126. Q. How may a freight triple valve be distinguished?

A. By its two exhaust outlets, one being plugged.

127. Q. When should the brass graduating spring of the Westinghouse freight triple valve be replaced with a new one?

A. When it is found to be less than 3 inches in length.

128. Q. When should a brass passenger triple valve spring be replaced with a new one?

A. When it is found to be less than 2¼ inches in length.

129. Q. To what travel of piston must the brakes be adjusted?

A. Not less than five inches nor more than six inches, and this adjustment must be made whenever the piston travel is found to exceed eight inches on a passenger car or nine inches on a freight car.

130. Q. How is the slack taken up so as to secure this adjustment?

A. By means of the dead truck lever, and if that is not sufficient one or more holes must be taken up in the underneath connection and the adjustment then made by the dead truck lever.

131. Q. What are the different holes in the outer end of the cylinder levers for, and why must the connections be pinned to the proper hole for each car?

A. These holes are to enable the adjustment of the brake pressure to be made according to the weights of different cars. The connection must be made to the proper hole in each case, according to the weight of the car, so as to give proper braking power, otherwise the brake will be inefficient, or the wheels may be slid under the cars.

THE PRESIDENT: Gentlemen, you have heard the report. What is your pleasure to do with it.

MR. PECK: I move that report be received and adopted.

The motion was carried.

THE PRESIDENT: It is now open for discussion. I think the adoption of it includes the possibility of discussion. Some may wish to ask some questions. If not, we will pass to the next subject.

MR. SINCLAIR: I move that the report be added to the standards of the Association. When that is done it keeps it distinct so that it is easily referred to.

THE PRESIDENT: I would ask Mr. Sinclair if the recommendation of the committee being adopted does not place it in that category.

MR. SINCLAIR: No, Mr. President.

MR. SETCHEL: It has been received and adopted.

MR. SINCLAIR: Yes; but it has not become a standard.

THE PRESIDENT: Well, to make it clear, will some one second Mr. Sinclair's motion?

MR. SETCHEL: I second it.

THE PRESIDENT: It is moved and seconded that these recommendations be adopted as standards of the Association.

MR. SINCLAIR: To make it plain, Mr. President, my object in making this motion is that the Master Car Builders' Association have it as recommended practice; we do not have any recommended practice, and we must either make a thing a standard or let it go in the body of the report after it has been presented to the Association, where, as has often happened, it is likely to be entirely forgotten after it has been in the body of the report for a few years; while if it is a standard it is reproduced every year.

MR. TONGE: I would like to know why it is considered good practice or why it is recommended to allow such a variation as 3 inches — 6 to 9 inches. Why should it not be confined to 6 to 7½ inches? That is a long range — 3 inches in range. On our through train from Minneapolis to Chicago, in connection with the Rock Island, we confine ourselves to 6 to 7½ inches. Trains are tested when received, trains are tested before the starting from the yards, and we allow nothing to leave the yards below 6 inches. We make it a point on these trains to confine ourselves to 6, and not below 7½ inches.

many as are in favor of that motion will signify by saying "aye"—contrary minds, "no." I can hardly decide on that. Those in favor will please rise.

Twenty-two arose.

THE PRESIDENT: Negative please rise.

Twenty-four members arose.

THE PRESIDENT: As it takes a two-thirds vote to adopt standards, the motion is lost.

MR. MORRIS: If I am in order, I will offer a motion that the report be received, and the corrections be incorporated in our proceedings, the same as they have been in previous reports and actions on Air Brake and Signal Instructions shown in the proceedings of 1897. (Seconded.)

THE PRESIDENT: I think that is all provided for in the receiving and adoption of the report, which certainly means that they shall be incorporated in the minutes of the proceedings.

MR. WAITT: I would like to speak once more in regard to that. Is it to be understood that the entire rules will be printed with these revisions, or will simply the revisions be shown, and will you have to refer back to other years to the old rules in order to get the new rules as revised complete? It seems to me it would be desirable to print the whole rules in the proceedings as revised. Then we will not have to refer back to the proceedings of former years in order to get them together.

MR. CLOUD: It has not been customary, as I understand it, to print the Air Brake and Signal Instructions in the Master Mechanics' report. In 1897 there was a report of a committee recommending certain changes in those instructions, which was published. If it is the wish of the Association, it would be all right to publish the revised Air Brake and Signal Instructions, as they will doubtless be adopted by the Master Car Builders' Association in the proceedings, but not as a standard. I think a motion to that effect would accomplish what those of you wish who lost the previous motion.

MR. MARDEN: I think I understand Mr. Waitt's position in the matter, and perhaps a suggestion of this kind might help the matter out. It is well known that the Air Brake and Signal Instructions are printed in pamphlet form and sent out to the different roads, and it seems to me it might be well, in order to have it understood that they are approved by the Master Mechanics' Association, that in

standards of the Master Mechanics' Association, or that they should be put there. These standards, as at present published, of the Master Mechanics' Association, are short, and refer only to certain matters, such as details of construction in the Master Mechanics' line, and consists of some ten pages. By this action, if it is carried, you will treble the number of pages of the standards of the Master Mechanics' Association, and make the great majority of it a lot of material that is not properly a standard of the Master Mechanics' Association, so far as I can see. It seems to me that the standards ought to be standards of construction. I do not see that much good would be accomplished by publishing these instructions as standards. They will appear in the Master Car Builders' proceedings, and in a special pamphlet sold to railroads for use among the men, which all of you will doubtless have.

MR. SINCLAIR: With the consent of my seconder, I will withdraw the motion.

THE PRESIDENT: I think that the mover of that amendment will have to be consulted in that — Mr. Waitt.

MR. WAITT: Mr. Chairman, I do not feel willing to do that. It seems to me that if these rules for instructions with regard to air-brake practice are of any value, or were of value enough to be submitted to a committee, if they are of value enough to be used, they should have the indorsement of the Master Mechanics' Association, and thereby be more likely to be put into use than if they simply go on record as a matter that has been up for committee examination and report, and then is dropped, and I hope that the Association will see the wisdom of including them in their standards. It seems to me it is of enough importance to be worthy of being placed there.

MR. PECK: I believe just adopting them will fill the bill. Of course, as Mr. Cloud says, they are not properly a Master Mechanics' standard; but might be a recommended practice. I think the adoption of them will do just as well.

MR. SETCHEL: Mr. President, if I am in order, I would make a motion to this effect, that we receive the report and recommend the adoption of the amendments made.

THE PRESIDENT: I think that has been pretty well covered. I think we had better take the vote on the recommendation as it stands. You have heard the motion as amended by Mr. Waitt. As

many as are in favor of that motion will signify by saying "aye"— contrary minds, "no." I can hardly decide on that. Those in favor will please rise.

Twenty-two arose.

THE PRESIDENT: Negative please rise.

Twenty-four members arose.

THE PRESIDENT: As it takes a two-thirds vote to adopt standards, the motion is lost.

MR. MORRIS: If I am in order, I will offer a motion that the report be received, and the corrections be incorporated in our proceedings, the same as they have been in previous reports and actions on Air Brake and Signal Instructions shown in the proceedings of 1897. (Seconded.)

THE PRESIDENT: I think that is all provided for in the receiving and adoption of the report, which certainly means that they shall be incorporated in the minutes of the proceedings.

MR. WAITT: I would like to speak once more in regard to that. Is it to be understood that the entire rules will be printed with these revisions, or will simply the revisions be shown, and will you have to refer back to other years to the old rules in order to get the new rules as revised complete? It seems to me it would be desirable to print the whole rules in the proceedings as revised. Then we will not have to refer back to the proceedings of former years in order to get them together.

MR. CLOUD: It has not been customary, as I understand it, to print the Air Brake and Signal Instructions in the Master Mechanics' report. In 1897 there was a report of a committee recommending certain changes in those instructions, which was published. If it is the wish of the Association, it would be all right to publish the revised Air Brake and Signal Instructions, as they will doubtless be adopted by the Master Car Builders' Association in the proceedings, but not as a standard. I think a motion to that effect would accomplish what those of you wish who lost the previous motion.

MR. MARDEN: I think I understand Mr. Waitt's position in the matter, and perhaps a suggestion of this kind might help the matter out. It is well known that the Air Brake and Signal Instructions are printed in pamphlet form and sent out to the different roads, and it seems to me it might be well, in order to have it understood that they are approved by the Master Mechanics' Association, that in

that pamphlet it be stated that those instructions are approved by the Master Car Builders' and the Master Mechanics' Associations.

MR. CLOUD: It is so stated.

MR. PECK: I think my motion covers the case exactly; that we receive the report of the committee and adopt it.

MR. CLOUD: I second Mr. Morris' motion to print the revised Air Brake and Signal Instructions in the proceedings, but not among the standards.

MR. MCINTOSH: There is still a motion before the house which, I think, must be entertained first — Mr. Peck's motion that the report of the committee be received and adopted is still before the house.

THE PRESIDENT: I think not. It has been voted on and passed.

MR. MCINTOSH: Pardon me, Mr. President, but I think it was an amendment that was voted down.

THE PRESIDENT: The report of the committee was accepted and adopted. Then the question came up of having them printed in the proceedings, and an amendment was made that they should be printed in the proceedings as standards, and that was voted down. Mr. Morris has made a motion that, contrary to past usage, the entire rules, as modified, shall be printed in the proceedings of this year. It has not been customary to print these rules in our proceedings. That has been moved and seconded. Is there anyone wishing to make any remarks? (Question called for.) As many as are in favor of the motion to have the rules as amended printed in this year's proceedings will please signify by saying "aye"— contrary minds, "no."

The motion was carried unanimously.

THE PRESIDENT: The next report is that of the Standing Committee on the Apprentice Boys.

MR. CLOUD: Mr. Clements, of Congress Hall, wishes me to say that convention rates will be good for ten days to any who wish to remain over.

Mr. Bradley gave an abstract of the following report:

## REPORT OF COMMITTEE ON THE APPRENTICE BOY.

*To the President and Members of the Master Mechanics' Association:*

In its reports to the Association in the years 1896 and 1897, your committee has already covered fully what it believes to be the proper way of handling apprentices,

and has made what seems to it to be an adequate set of recommendations on the subject.

At the convention of 1897 this committee was made a standing committee. We assume, therefore, that it is the desire of the Association that the work of reframing and systematizing the methods under which apprentices are at present handled in this country should be a continuing one, until permanent results have been obtained. With this end in view, your committee believes that the first essential step is that this Association should adopt as standard a general code for the treatment of apprentices in the shops. This code should be as simple and elastic as possible. It should cover only the elementary and necessary conditions of a proper apprentice course. It should be such as can be accepted without difficulty by railway shops of all sizes and in all parts of the country, as well as such as to commend itself to the acceptance of the management of shops other than those of railway companies. Being of this general and universally acceptable nature, the code should then be adopted by this Association in such a way as to give it as binding force as possible on members of the Association.

Your committee has drawn up such a code of rules, which it believes to be sufficiently broad to be generally acceptable. Your committee also believes that the general adoption even of those elementary rules will be of great benefit, and that they will serve as a foundation on which a complete system, uniform in its details, can ultimately be built. Your committee also submits a set of supplementary recommendations which are not intended to have the binding force given to the rules proper, but are intended only to be explanatory of and auxiliary to them. We recommend the adoption of the code of rules as given below, to be known as "The Standard Code of Apprenticeship Rules of the American Railway Master Mechanics' Association." We also recommend the adoption of certain resolutions of instructions which will enable this committee to assist in getting the rules generally adopted.

We ask the Association to adopt the following:

*Resolved*, That the following code of rules be adopted by this Association, to be known as the

## STANDARD CODE OF APPRENTICESHIP RULES OF THE A. R. M. M. A.

1. A regular apprentice is one who has had no previous shop experience and is not a graduate of a technical institution.

2. No regular apprentice shall be taken into the shop below the age of fifteen or after the age of nineteen years.

3. No apprentice shall be taken into the shop who has not received the elements of a common education, and who does not give evidence of such capacity as to promise the ability to become a competent mechanic.

4. No apprentice shall be taken into the shop without the consent of his parents or lawful guardians, who shall have a thorough understanding of the conditions of such apprenticeship, and who shall execute such documents, including a release of the company from liability for accidents to the said apprentice, as the company may require.

5. The term during which an apprentice shall serve before receiving a certificate of apprenticeship shall not be less than three years nor more than five years.

6. There shall be a regular apprentice course framed for each shop, which course each apprentice shall go through during his term, the time to be spent on each class of work being defined, and such definition shall be observed as closely as practicable with due regard to the capacities and condition of the individual apprentice.

7. During the term of the apprenticeship a careful and proper record shall be kept of the work and progress of the apprentice, and also of the general behavior and conduct, which record shall be entered on properly authorized blanks or books provided for the purpose not less frequently than once every week during such term.

8. Each apprentice shall be paid for the work done by him upon a scale duly agreed on and provided for in advance.

9. Under no circumstances shall the company assume any liability for the employment of an apprentice after the conclusion of his term.

10. On the conclusion of the term of apprenticeship, each apprentice shall be given a certificate in a proper form, duly signed by the proper officer of the company, which shall set forth the length of time which each apprentice has served and the work on which he has been engaged, as well as some indication of his general behavior during his term.

11. Apprentices who have already served part of a term in other shops, or who have taken part of a course at a recognized technical institution, may be received under such modifications of the foregoing rules as may be deemed proper.

## RECOMMENDATIONS SUPPLEMENTARY

TO THE

## STANDARD CODE OF APPRENTICESHIP RULES OF THE A. R. M. M. A.

RULE 3. An apprentice should be able to read and write and have a knowledge of arithmetic. Some companies insist that a candidate shall have reached a point in his studies equivalent to that of the eighth grade of the public schools. This standard, where applicable, will be found satisfactory.

RULE 4. The following is a blank form of release which is recommended as satisfactory:

## APPENDIX "C."

(Form for Release of Minors.)

WHEREAS, The A. B. C. Railroad Company has agreed to take into its service ........................................................................ a minor, subject to discharge at the pleasure of the company, and has agreed with our consent to pay him the compensation to be earned for his services, and has been authorized to take from him such receipts and acquittances as the said company may require;

AND WHEREAS, The said ..........................................., by reason of such employment, will be subjected to great risk of personal injury from neglect of other employes, agents and officers of the said company, and from defects of machinery, and from other causes;

AND WHEREAS, In the event of injuries to the said ...................... ..............................., whether resulting fatally or otherwise, the said

.......................................................... or members of his family might make claims for damages against the said company;

Now, in Order to release the said company from all claims or liability for damages for injuries of any and all kinds, from any cause whatsoever, ............
............................................................ the father, and
............................................................ the mother, in
their several and individual capacities, and acting as guardian for the said ........
............................................................, and the said
............................................................ himself, in
consideration of the employment by the said railroad company of the said ........
.......................................................... in the service of the said company, and in consideration of the sum of one dollar now in hand paid by the said company, do hereby release and forever discharge the A. B. C. Railroad Company for all claims for damages, and do also further agree to release the said company from all claims and liability for damages arising out of any injury or injuries to the said ....................................................
resulting from the character of his employment, from the negligence of other employes, or agents or officers of the said company, from defects of machinery or any other cause or causes whatsoever, whilst a minor and whilst in the service of the said company in any capacity whatsoever.

Witness our hands and seals this .................. day of ....... 18...

| | |
|---|---|
| | ..............................[SEAL] |
| Witnesses: | ..............................[SEAL] |
| ............................ | ..............................[SEAL] |
| ............................ | ..............................[SEAL] |
| ............................ | ..............................[SEAL] |

Rule 5. Four (4) years is recommended as the best standard term. Whenever possible this should be adopted. The limits given in the rule, "not less than three nor more than five years," are made sufficiently wide to cover all special cases. The brightest and most ambitious boy should not be permitted to complete his course in less than three years under any circumstances. A boy who does not complete it in five years had better be something else than a mechanic.

Rule 6. The following courses are recommended for the various shops:

## MACHINE SHOP.

Tool Room.—General use of tools, names, etc., work on small planer, drilling machine, shaper and lathes, provide tools; six months to actually serve.

Erecting Shop.—Helping on general work—gang No. 1, one month; helping on general work—gang No. 2, one month; helping on general work—gang No. 3, one month.

Machine Shop.—General instructions, milling machine, boring mill, horizontal machine, axle lathe, and helping in general; three months to actually serve.

Boring, driving and truck brasses and quartering machine; two months.

Cylinder boring machine and planer; one month.

Rod: Rod gang, three months; small lathe (alone), two months; large slotter, one month; brass lathe, two months; small planer, one month; large and small

planers, two months; driving wheel lathe, one month; large lathe (alone), two months; motion work lathe, one month; general vise work, three months; surface table, three months.

ERECTING SHOP.— General work — gang No. 1, five months; general work — gang No. 2, three months; general work — gang No. 3, four months.

Total number of months' actual service — forty-eight.

Your committee submits this as a basis for an adequate course of training in the machine shop, with the distinct understanding that it is to be qualified so far as the term of service to be spent in the different items, and also in the whole course, by the quality and capacity of the individual boys, under the discretion of whoever has them in charge.

## BLACKSMITH SHOP COURSE.

1. To start the apprentice on a bolt machine for six months. Here he will learn the rudiments of heating iron; also the setting and adjusting of dies, and at the same time by observation will learn the names of the tools and their use in that portion of the shop.

2. The next six months in operating a steam hammer. In this position he has a good opportunity to note how the blacksmiths handle and form iron; at the same time require him to help at the fires in the immediate vicinity of the hammer.

3. The next six months should be as a helper on a small fire, with a man who is quick and handy with light work.

4. The next six months on a light fire without a helper, where he will learn to handle the hand hammer.

5. For the next three months give him a light fire with a helper; the fire should be so located that he will be called on to assist in taking heats for the larger fires.

6. For the next six months on heavier work that does not require skill.

7. For the next three months put him helping at the tool-dressing fire, and if the shop has two tool-dressing fires, the next three months on the second tool-dressing fire.

8. The next twelve months put him on a heavy fire with as much of a variety of work as can be arranged.

## BOILER SHOP COURSE.

1. The first three months heating light rivets.

2. The next three months helping on the heavy sheet-iron work, such as wheel covers, ash pans, etc.

3. Three months holding on rivets for tank work.

4. Three months holding on rivets for boiler work.

5. Six months riveting on patches, chipping and calking on tank work.

6. Six months setting flues.

7. Six months patching and bracing boilers, chipping and calking and general riveting.

8. Six months blacksmithing, to learn how to make and fit braces, to dress necessary tools and assist in fitting up his work.

9. The fourth year to lay out flange and do general boiler work.

RULE 7. It is recommended that some one person be given direct charge of all apprentices and be held responsible for their proper instruction. He can be known as "the Foreman of Apprentices," or he can be designated to perform the duties, without special title, in conjunction with his ordinary work. The following blank page for an Apprentice Record Book is recommended:

# APPRENTICE RECORD.

| NAME. | WEEKS. | | | | | | | | | | | | | | | | | | | TOTAL WEEKS WORKED. | AVERAGE CREDIT. CONDUCT AND ABILITY. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 up to 52 weeks. | | | | | | | |
| John Doe | 80 | 50 | 90 | 70 | 50 | 30 | 90 | 80 | 70 | 50 | 30 | 90 | 80 | 70 | 40 | 70 | 80 | 50 | 30 | | 63 |
| James Smith | | | | | | | | | | | | | | | | | | | | | |
| Chas. Jones | | | | | | | | | | | | | | | | | | | | | |

RULE 8. The scale of pay must be governed largely by geographical and individual conditions. It is recommended that the rate of pay be 50 cents for a ten-hour day for the first year, with an increase of 25 cents a day for each year thereafter. For an eight-hour day 40 cents a day at the start and 20 cents a day increase yearly.

RULE 9. The following form of certificate is recommended:

APPENDIX "B."

(Form of Certificate of Apprenticeship.)

A. B. C. RAILROAD COMPANY,

MOTIVE POWER DEPARTMENT.

CERTIFICATE OF APPRENTICESHIP.

..........................................................................

has served an apprenticeship as..........................................

at the shops of this Company at..........................................

during the period from........................to..........................

and has made......................hours' time over 10 hours per day.

WORK ON WHICH EMPLOYED.

| APPROXIMATE NO. OF MONTHS. | KIND OF WORK. |
|---|---|
| ........................ | ........................................ |
| ........................ | ........................................ |
| ........................ | ........................................ |

OFFICERS UNDER WHOM EMPLOYED.

| NAME. | TITLE. |
|---|---|
| .................................. | .................................. |
| .................................. | .................................. |
| .................................. | .................................. |

GENERAL RECORD OF APPRENTICE.

..........................................................................

........................ ....................................

*Supt. Motive Power.*

In addition to the foregoing specific rules and recommendations thereupon, your committee desires again to call attention to departments of this subject which have been treated in former reports.

It is desirable that apprentices should be given the opportunity of acquiring general knowledge of the departments of railways in addition to the work inside

the shops. This must be largely a matter for the judgment of the officers of individual companies, but valuable talents may be discovered by giving a boy a chance to get some acquaintance with the drafting room, with signal work, with transportation and operating methods. At the worst, such an acquaintance will not make a mechanic a poorer workman.

It is very desirable that apprentices should receive some instruction of a scholastic nature outside the shops during their term. This, again, is largely a matter of individual judgment, in accordance with the size of the shops and the facilities in the neighborhood for the furnishing of such instruction. We incorporate in this report, as an appendix, a letter written by one of the members of this committee, the letter having been written for presentation to a meeting of this committee at which the writer was unable to be present. We again call attention to the recommendations of this committee, in its previous reports, on the subject of courses for technical education, and in conclusion we will most respectfully ask for authority to conduct such correspondence with the individual members of this Association, with railway companies, with educational institutions and the officers or committees of other associations or societies as will enable your committee at least to ascertain what the prospects are of getting for the Association the encouragement and support which will be necessary if it is to be able to work any real and permanent reform in the present apprenticeship methods. While the action of this Association in its annual conventions must always be the most vital force in bringing about such reforms, that action must be supplemented by active work during the year by your committee, for which your committee must be given, and desires, large discretion.

In conclusion, we recommend that this Association adopt a resolution requesting the Master Car Builders' Association to appoint a standing committee to confer and act in concert with this committee. We also recommend the adoption of a resolution instructing the secretary of this Association to call the attention of the Master Blacksmiths' Association, the Association of Air Brake Men and the various railway clubs and societies to the importance of this subject as a topic for discussion, and assuring them of the desire of this Association to have their co-operation in our efforts to bring about a reform.

W. F. BRADLEY,
W. H. HARRISON,
G. R. JOUGHINS,
A. E. MANCHESTER,
H. P. ROBINSON,
*Committee.*

## APPENDIX TO REPORT OF COMMITTEE ON THE APPRENTICE BOY.

BEING A LETTER BY MR. G. R. JOUGHINS.

It is my conviction that the question of a scientific education is the most important part of our work. I will confine myself to that aspect of the subject. I am particularly interested in it, because I have taught the apprentice boy in science schools for many years, and my experience of the benefits resulting therefrom have been most satisfactory, both to the pupil and the railroad company.

It is a long time since I taught in those schools, but I can recall the names of many of my pupils, some of whom never got beyond the workbench, but others who were talented have risen to high positions entirely through the knowledge acquired in those evening classes and the stimulus to reading and study which they naturally obtained through attending such schools. My experience, therefore, has altogether been in favor of educating our boys, not expecting that they will all attain responsible positions, but because even those who are dull will become better workmen, and the few who possess real ability will be separated from the ordinary mechanic and given an opportunity to rise above their surroundings and do better work in the world. If only for the sake of these few and for the good work which they will do in our profession and for our country, we ought to put forth every effort to make it easier to obtain a scientific education, and by largely increasing the number of schools make it more universal than at present.

I believe, therefore, that the importance of the question of educating our apprentices cannot be overrated. It is a large subject and one of which a broad view should be taken. It is of national importance, the prosperity of our nation largely depends upon it, because educated workmen are the backbone of a manufacturing country, such as ours. I am, therefore, deeply convinced that we ought to do all that is possible to impress upon others the great value of the work and induce them to give a helping hand to push it along.

It appears to me that as the Master Mechanics' Association is a national organization, it has an excellent opportunity to do good work. It can make its influence felt more extensively than any other body; it can recommend courses of teaching and obtain uniform results throughout the United States which no Federal authority, State college or university can do.

I do not agree with those members of the Association who suggest that each apprentice should pay the full cost of instruction and that he should depend on his own manly efforts for an education. That principle is not applied to the education of anyone else, no matter what school, college or university he may attend, or what profession he may adopt. I believe it to be absolutely necessary to assist apprentices, and to assist them very substantially, both in school fees and in books. Various ways can be taken to raise money to help them, without making it a serious burden upon the railroad companies; it is done at the present time in some places, and could be done in all.

With enough money it is, in most places, easy to obtain a teacher; and in those places which are too small to support one, the correspondence schools could be used, but the necessity of giving assistance to the apprentices, in whatever way the education may be given, will always remain.

Having persuaded our members and the roads they represent to raise the funds necessary, the Association ought to map out a plan of education, naming the subjects in which examinations will be held and giving a list of the text-books, thus insuring uniform teaching. Then at the end of the session examinations should be held at the different schools, using the same examination papers, which could be prepared by some of our college friends, who so kindly offered to help, and which each school could order at cost price from the Secretary of the Master Mechanics' Association in sufficient quantities to suit. In this way a system of certificates of acquirements

could be issued on a uniform standard, and which would prove of incalculable value both to the employer and employe.

Intimately related to the school question is the establishment of a technical library, which, no matter how small the beginning, could be gradually built up.

The Association should also find out what scholarships for mechanics, mathematics, etc., are given in each State or college for which our apprentices might compete, and publish them, special stress being laid upon the existing Master Mechanics' scholarship at Stevens Institute.

If the proposed plan should meet the approval of the committee, and nothing better be offered, I have no doubt but that it could be carried out. The first step toward the desired end would probably be to issue a circular to all members of the Association, giving an outline of the work which ought to be done, and of the possibilities in the direction of a better education for our apprentices; we would then ask what educational facilities are already afforded in each shop or town, including the Y. M. C. A. courses; also details as to what deficiences experienced, books used, cost of courses, and what assistance or encouragement is given by the railroad company or officials. After receiving and digesting the answers — which should be returned promptly — to these questions we might be able to issue a circular pointing out the different ways in which funds can be raised, pointing out the importance of the subject, and asking each member or each railroad company what they would be willing to do toward the desired end.

The proposed science schools would not, of course, be confined exclusively to locomotive railroad apprentices. Apprentices from other shops who wished to join should be heartily welcomed on an equitable financial basis. Other organizations might wish to join in the plan of education, and should be encouraged to do so, but in the meantime the Master Mechanics' Association should go forward in the good work, and we, as its committee, should find out what ought to be done, what the railroad companies are willing to do, and make the best recommendations within our power to further the highest interests of the apprentice, which no doubt lie in the direction of a scientific education side by side with careful training in the workshop.

THE PRESIDENT: Gentlemen, you have probably read the report of the committee. You have heard the remarks of the chairman. What is it your pleasure to do in the matter?

MR. PECK: I will offer this resolution to assist the committee:

*Be it resolved*, That the standing Committee on Apprentice Boys is hereby authorized to correspond with the Master Car Builders' Association, the American Society of Mechanical Engineers, the Manufacturers' Association and other kindred societies, with a view of adopting a uniform system of accepting and training apprentices.

(Seconded.)

THE PRESIDENT: It is moved and seconded that the resolution read by Mr. Peck be adopted. Is there any discussion?

MR. DAVID BROWN: I do not see that the other associations mentioned are under the same conditions that we are in this matter. For

instance, the Master Car Builders are not under the conditions that we are, and the other associations also mentioned. I do not see how they could frame any matters for us. I think this Association ought to attend to the matter themselves.

MR. BRADLEY: In reply to what the gentleman says, I think he probably is a little mistaken. The American Society of Mechanical Engineers is not strictly a technical society. Almost all of the large manufacturers of the country are members of the American Society of Mechanical Engineers. Men who handle large establishments, building all kinds of machinery, have membership in that association, and men who are superintendents of large shops and large manufacturing establishments have membership in that association, and they handle such subjects in a similar manner to what we do — though I do not know of their ever having discussed this particular question. But it was new to this Association two or three years ago.

MR. PECK: It merely gives the committee more ground to work on. There is nothing detrimental about it. Their pasture is about run out, they claim, and this is simply to give them more ground to work on.

MR. TONGE: The adoption of a regular system may tend to do good with some people, but you have got to block out your own line, so far as the apprentice boy is concerned, according to the size of the shop you have. In the first place, you have got to know if you have got a good apprenticeship formula. If you have not, you are not going to have good apprentices. In the next place, you want to assign a certain amount of machinery through which they shall pass, and after you have got a number of apprentices they will then move in regular form, as you bring them in the shop. The movement becomes very easy. It becomes very easy to manage in any shop, say twenty-five or thirty apprentices, while with a shop force of seventy or eighty sometimes, it is no trouble when the system is organized. After they have passed through the machine portion, they are then turned over to the gang force. They are allowed to work in the gang force at suitable work for a period of two or three months before they are given a chance along with the general workmen. I had this apprentice system in force on the Baltimore & Ohio for eleven years, from 1874, and have had the same practice in force on the Minneapolis & St. Louis for the last thirteen years, and I find that it works very well.

Mr. Sinclair: Before the discussion becomes general, I move that the report be received. (Seconded.)

Mr. Bradley: Mr. President, I think it would rather be better to have the members address themselves to the question of the resolution, as to what authority be given to this committee, and then, if that resolution is accepted or rejected—if the resolution is rejected—then it would be unquestionably in order that the committee be discharged and the subject dropped for a year or two, or that it be continued to report whatever they learn in the scope of this Association—if the members would hold to this resolution to enlarge the scope of the committee.

The President: I would say that I was going to call some of them to order on that particular point. The resolution I consider in order from the very fact that it is based on a recommendation of the committee and should be heard from before passing upon whether the report of the committee should be accepted or not, and it might have an influence on whether the committee should be continued or discharged. Those who wish to speak on this subject must confine themselves to the resolution that is before the house, and not discuss the report until after the report has been accepted.

Mr. Marshall: As I understand the resolution, it is as to whether the work of this committee shall be broadened to include the coöperation of other societies. It seems to me there is one point to be borne in mind, and that is that if we seek the coöperation of manufacturers' associations and mechanical engineers' societies, etc., we include practically the entire manufacturing interests of the country, and we are apt to run against the opposition of labor organizations where we would not if we confined this to ourselves. Furthermore, if we take the matter and straighten it out satisfactorily to ourselves it is very easy to get other organizations to fall in line. It might defeat our object if we get it too broad.

The President: Do any others wish to express themselves on the resolution? If not, those in favor of the adoption of the motion as presented by Mr. Peck will signify by saying "aye"—contrary minds, "no."

The motion was lost.

The President: Now, gentlemen, the acceptance of the report of the committee is before you.

Mr. Setchel: I move that the report be received. (Seconded.)

THE PRESIDENT: It is moved and seconded that the report of the committee be received. Does that include the adoption of their recommendations?

MR. SETCHEL: No.

THE PRESIDENT: I think not. Those in favor will signify by saying "aye"— contrary minds, "no."

The motion was carried.

THE PRESIDENT: It is open for discussion now.

MR. WAGNER: I have not anything to say on the report proper, but there is something I would like to say about the appendix. I have read this appendix to the report of the committee, and most heartily indorse what the author has said concerning the value of night schools. If I mistake not, the committee last year suggested taking up the matter of starting the night school with the various college or university authorities. In view of this sentiment, and the interest in night schools, and the greater interest now taken in technical education, or the training of engineers as so ably illustrated in Professor Goss' lecture last evening, I feel more impressed with the necessity of organizing throughout the country night schools for young mechanics or artisans that will work into the hands of our technical schools. The author recommends steps to be taken toward the raising of funds, and in this connection I would state that I believe from my own experience there will be no difficulty in raising funds for the maintenance of night schools of this kind in a community where mechanics and apprentices are employed. I had the pleasure of being instrumental in starting such a school some six years ago which is now producing gratifying results. Several of our pupils from this night school have passed the entrance examinations in a technical university with practically no other preparation except that received at the night school, and they are in very good standing in their classes. I will say that we have a night school which started from just such a suggestion as given in the appendix, with a fund of $120 raised by a sociable, and we are now spending $1,500 a year, collected by subscription, and are charging the pupils $5 a year. We have school three nights a week, giving courses in mechanical engineering and mining engineering. The author of the appendix also refers to courses, and that the Master Mechanics' work affords opportunities for a course which will be very interesting. In this connection I would say that I heartily agree with that, as there is a uniformity of work. I can see the point there from

the interesting course that can be framed where the mine bosses must pass a careful examination before they can hold that position, and so it would be here. For a certain line of work we have certain rules to follow that the men are supposed to know, and I can see that a very good, interesting course, and a general course which could be uniform and universal throughout the whole country, could be established, and I wish to express my hearty indorsement of what is said by the author of the appendix.

MR. DAVID BROWN: Mr. President, the appendix is very good. It is very well for the boys to enable them to get a good education, if they would only attend to it. We have got means in Scranton, in the neighborhood I am from, of the boys attending the Railroad Y. M. C. A., and also the local Y. M. C. A. established in the city. Both are very good in their way, but they do not seem to take hold as they ought to. They have got every means of attending to it for very little money. Now, as regards the adoption of the report as it is here, I do not see that it could be followed right through the whole of it. They say here:

MACHINE SHOP TOOL ROOM.— General use of tools, names, etc.; work on the small planer, drilling machine, shaper and lathes, provide tools; six months to actually serve.

ERECTING SHOP.— Helping on general work—gang No. 1, one month; helping on general work — gang No. 2, one month; helping on general work — gang No. 3, one month.

MACHINE SHOP.— General instructions, milling machine, boring mill, horizontal machine, axle lathe and helping in general; three months to actually serve. Boring, driving and truck brasses and quartering machine; two months. Cylinder boring machine and planer; one month.

ROD.— Rod gang, three months; small lathe (alone), two months.

I suppose up to the present time he is along with some one else; he is not working with the machine alone.

Large slotter, one month; brass lathe, two months; small planer, one month.

We notice that he has been with the small planer the first six months.

Large and small planers, two months; driving wheel lathe, one month; large lathe (alone), two months.

That is the second time that he is alone. Consequently he is with the other men running the machine up to the present time, whatever it may be.

Motion work lathe, one month; general vise work, three months; surface table, three months.

Erecting Shop.— General work — gang No. 1, five months; general work — gang No. 2, three months; general work — gang No. 3, four months.

By that he is changed to different gangs to give him an idea of the different gang bosses.

Total number of months actual service, forty-eight.

Now, we will take the first. That is all right, probably. You can get around six months and it will be to advantage. But I would not be in favor of his being along with the other men all the time. He ought to be doing something alone. Then we go on now to general instructions.

Milling machine, boring machine, horizontal machine, axle lathe and helping in general; three months to actually serve.

He is along with that man the whole of that time. He is not alone. That man will certainly not be attending to his business as well as he would if he were by himself. I am speaking of the machine man. He may have that boy with him, chinning all the time, and he will get him finally so that he won't be fit for much else but talk. Then we go to the boring, driving and truck brasses and quartering machine. He has two months there again with somebody else. He cannot do either of those jobs himself. He would not be able to bore those brasses up to the present time, nor would he be able to do anything with the quartering machine.

Cylinder boring machine and planer, one month.

He is there with that party again.

Rod.— Rod gang, three months.

What can he do in the rod gang at that period? No use at all there. There is not much use for a boy of that experience in a rod gang up to the present time. Now, our method of doing it is, we give him one year in the erecting shop and one year in the turning shop, before he does anything else. He then decides which shop he will stay in. If he is in the turning shop, he goes generally from the small planer where they plane the valves, etc. He is left with a boy that knows the way with it two or three days, and after he is able to attend to it himself, the other boy is removed. He stays there a while. From that he goes to something else, probably the drill press. After he is there a year, then he goes out of the erecting shop. We do not in all cases put him in the turning shop first. When he is in the erecting shop, he is doing any little thing he can at first. He gets to use his tools and he is put with machinists on different work where they want a little help. At the end of that year he is removed to the turn-

ing shop. In either case, when the two years have expired, we ask him: "Which branch would you prefer? Do you wish to stay in the turning shop, or do you wish to stay in the erecting shop?" He then decides and from that on he is kept in either one shop or the other, and he is changed around from one machine to another until he gets efficient. He is not put with anybody else any more of the time than just to know what to do with a machine.

MR. MCINTOSH: I take it that the committee has outlined an ideal method, one which it will be very well to follow whenever it is practicable to do so, but it is more in the way of placing before this Association a general plan than it is with the expectation that it will be followed rigidly. I think the method outlined will be very well, and it will only be expected that the railroad shops will follow it as closely as possible or as they find it practicable.

MR. TONGE: As I said before, there is only one way for you to do, and that is to outline what you are going to teach your boys. It is of no use to try to cram the instruction of the machine shop and Cornell University through a lad in four years. You cannot do it. You have got to take him just through such courses as you know that he can grasp; keep him a certain limited time at each position. We start in our apprentices in one way only. We make no exception, no matter whether it is the son of the president of the road or anyone else; he has got to start at the same point, and if he does not like it he can leave it, and if he does not suit us we will put him out of it. That is our system of doing business. He starts with the nut-topper, goes on the bolt machine, goes to the small engine lathe, large engine lathe, and then goes on the other side of the shop. We do not accept in our shop anyone, no matter what has been his condition, no matter whether he has been in any other shop or not one or two years, or whether he has been in college or not — he has got to start at the bottom and go through the proper course, for this reason: that it has been my experience in twenty-five years that to start anyone otherwise than that, because he is the son of the president or somebody else, why, you are going to create disharmony among your apprentices, and, as a consequence, you are not going to get good results. You must draw the line there.

MR. MANCHESTER: When the first report of this committee was discussed by the Association, it developed that in many of the railroad shops of the country many young men were taken in, ostensibly to learn the trade, but were put on a drill press or small planer and

kept there for the remainder of their lives, and it was with the view of outlining something, at least, to place something before the convention that would overcome the difficulty which the discussion indicated, that we have laid down a recommended line for the apprentices to follow. We have also stated in the report that this should be modified in accordance with the conditions, and to suit the shop in which the apprentice was employed.

MR. QUAYLE: On this question some of the remarks that have been made I do not just agree with. All boys are not alike. In our public schools today if every boy had to stay in a grade until every other boy was to pass, the ability that he had within him would not be shown. I do not believe in holding one boy back because another boy is stupid. If I prescribe a certain length of time that a boy shall stay on a certain tool, and I find that that boy can just do twice as much work and has twice as much intelligence as some other boy, I do not think it is right, because I have some fixed rule, that he should remain there. I think the boy ought to be pushed ahead about as fast as he is capable of going. I do not believe that you or I would like in our business — I do not believe you would like to be promoted on that scale because somebody is in the shop who claims seniority over you, that he ought to be held back because you are an older man, or because you have some fixed rule and cannot go beyond that point. I believe that merit ought to count. I believe that you will agree with me that boys are like tools in a shop. Some shops are fitted with special tools to do special work. They have the facility. They have turret lathes to do certain work on which you can turn out several times more work than on the old engine lathes. I believe that the majority of the boys who come from our technical schools, having received a technical education, having arrived at the years of discretion, having arrived at years of mature judgment and having arrived at years of superior ability to the boy who comes in at fifteen years of age, have an advantage over him. While the technical graduate has not facility with shop tools, he has the education. He has the facility which, if he uses it properly (and he ought to have the judgment, because of his maturer years), he can push ahead of the boy of fifteen or sixteen who has not been properly equipped educationally for the work. For that reason I do not believe in this idea of holding a boy back if he has ability, whether he is a technically educated boy or whether he has had only a common school education, or a very inferior education. If he has the ability mechanic-

ally to push against the other boys, I say give him the opportunity, and do not put any weights on him to hold him back. I have read this report with a good deal of interest, and while I am frank to say that perhaps there are some things in it that might not suit my shop, and might not suit your shop, it can be made sufficiently elastic at least, and you can adapt part of it to the conditions that surround you at the place that you have charge of. We are not expected to take up all of these things. If you keep a boy a little longer on a certain tool, or certain class of work, it is your privilege to do so.

I am particularly interested also in the letter attached by Mr. Joughins on the educational part of it. I think that a great many of us here who had, perhaps, to work harder nights and through longer hours to get the education that we have, can appreciate the fact that the boys of today have a much better opportunity of receiving an education than some of the older members of this Association had, and that fact ought to stir us up to the necessity of giving these boys such opportunity as is necessary to make them stalwart in their profession and in their business. I do not know that we need to say very much more about this, but I would move you that inasmuch as this committee have done excellent work for the last two or three years, and it does seem now that they might at least be given a rest on this subject until we look into it a little further, that for the present, at least, the committee be discharged. (Seconded.)

THE PRESIDENT: It is moved and seconded that, for the present, at least, this committee be discharged. Are there any remarks to be made before the motion is put?

MR. FORSYTH: Mr. President, I would ask if this motion would not entirely dispose of the subject.

THE PRESIDENT: It will unless it is brought up again and a new committee appointed. There is no definite time for which they are suspended or discharged.

MR. FORSYTH: I think the important question for us is whether we are going to adopt this report and adopt the standard code of apprenticeship which it has recommended. I understand that it has not been adopted.

MR. QUAYLE: I thought that it had been acted upon and I respectfully withdraw my motion, with the consent of the seconder.

THE PRESIDENT: The report has been received but not adopted.

MR. FORSYTH: Then, if I am in order, I would move that the

code of rules which the committee has recommended be adopted, not as a standard, but simply as a code of rules which this Association now recommends. It has been shown that these rules and the code of apprenticeship as outlined are not perfect, and that we do not want to adopt it exactly as it is, but that it can be used in a way. It is not in such shape as to be dignified by the term standard. I am entirely in favor of Mr. Quayle's motion to discharge the committee, but at the same time I should like to see the work of the committee left in some shape so that it can be used, and I would move therefore that in place of adopting the resolution which they ask us to, that it be changed to read that the following code of rules be recommended by this Association, and that instead of the words "standard code" it simply read "a code of apprenticeship," and in page 3 instead of reading "standard code" it simply read "code of apprenticeship." (Seconded.)

THE PRESIDENT: You have heard the motion as made and seconded. Are there any remarks to be made before it is put to a vote? All those in favor of the motion as stated by Mr. Forsyth please signify by saying "aye"—contrary minds, "no."

The motion was carried.

MR. QUAYLE: Now, Mr. Chairman, I move you that the committee be discharged. (Seconded.)

MR. SETCHEL: Is that necessary? Receiving the report of a committee discharges it always.

THE PRESIDENT: Not a standing committee. This is a standing committee and the receiving of the report or even the adoption of their recommendations does not, as I understand it, discharge such committee.

MR. SETCHEL: It has been always the case with every committee appointed that the acceptance of their report discharges the committee unless they are continued.

MR. QUAYLE: This committee was appointed as a standing committee from year to year until discharged.

MR. SETCHEL: I withdraw then, I did not so understand it.

MR. QUAYLE'S motion that the committee be discharged was carried.

THE PRESIDENT: We will now listen to Mr. Setchel, chairman of the committee appointed to consider the recommendations made by the Chair at the opening of the convention.

Mr. Setchel read the following report:

*To the American Railway Master Mechanics' Association:*

GENTLEMEN,—Your committee to which was referred the recommendations made in the President's annual address would respectfully beg leave to report: That we believe the suggestions made therein as to a consolidation of the two Associations under one organization are wise and timely made, and should be carried into effect at the earliest practicable period.

A large per cent of the car mileage representation in the Car Builders' Association is controlled by Superintendents of Motive Power or Master Mechanics who are members of the Master Mechanics' Association, in which all Master Car Builders are eligible to membership, and there would, therefore, seem to be no good reason why all business pertaining to construction and repairs of railway rolling stock, whether of engines or cars, should not be transacted in one Association and at one convention.

Fully one-half of the time of members from duty would be saved and a corresponding proportion of expense to the railroads. With one organization the business which now takes practically two weeks would be accomplished in one, and the six days now spent in convention can be reduced to four and fully as much work accomplished.

The successful merging of the two Associations would then render it quite possible, under proper restrictions, to carry out the suggestions of the President looking to the establishing of an interchange of motive power equipment in certain localities, as well as making it advisable to appoint a standing committee for conducting tests and indicating to members the necessary requirements for interchange motive power.

Your committee does not suggest that the combined organization should retain the name of either of the two present associations, for we believe a more suitable and comprehensive one may be found that will give entire satisfaction. But your committee does recommend, and we believe that railroad managers will insist, that the supervision of railway rolling stock now exercised by two Associations shall be placed under one organization.

Your committee would, therefore, recommend that the Executive Committee of this Association be and are hereby instructed to at once confer with the Executive Committee of the Master Car Builders' Association and endeavor to arrange for a consolidation of the two Associations under such name and conditions of membership as will do full justice to both Associations and accomplish this very desirable object; and the President of this Association is authorized and directed to appoint a special committee, who shall also be members of the Master Car Builders' Association, to attend the next annual meeting of the Master Car Builders and present this subject for consideration. Respectfully submitted.

J. H. SETCHEL,
A. M. WAITT,
PETER H. PECK,
*Committee.*

[Applause.]

On motion of Mr. Brown, the report was adopted.

THE PRESIDENT: We now have the report from the Committee on Subjects for the coming year, Mr. W. H. Thomas, chairman. But I

believe he has placed his report in the hands of the Secretary, and I will ask him to read it.

Mr. Cloud: A portion of this committee's report was printed in the programme as questions for topical discussion this year. The report as a whole is as follows:

The Committee on Subjects proposed the following subjects for topical discussion, and would recommend that the discussion be limited to ten minutes on each discussion, no member to speak more than once until all who wish have spoken:

1. The Special Apprentice. To be opened by Robert Quayle.

2. Is it possible to arrange the front ends of locomotives so they will clear themselves of cinders without throwing sparks? To be opened by J. H. McConnell.

3. The advisability of a systematic course in engineering in connection with technical schools. To be opened by Prof. H. Wade Hibbard.

4. The use of steel in locomotive construction. To be opened by J. E. Sague.

5. To what extent, and with what success, have the recommendations of the Committee on Exhaust Nozzles and Steam Passages been adopted? To be opened by A. L. Humphrey.

6. Has not the time arrived when air-brake instructors can accomplish more by instructing those who maintain brakes how to maintain them, than to instruct those who use them how to use them? To be opened by William Forsyth.

7. The best arrangement of flanged and bald tires on ten-wheel locomotives to secure the least wear of tires and rails. To be opened by A. E. Mitchell and G. R. Henderson.

8. When double headers are used on passenger or freight trains, is it good practice to cut out the brakes on the head engine, and does this comply with the requirements of the law? To be opened by T. R. Browne.

9. Is the use of fusible or soft plugs in the crown sheets of engines advisable? To be opened by William McIntosh.

10. What advantages are gained by the use of piston rods extended through the front cylinder head? To be opened by R. H. Soule.

11. When extended piston rods are not used, which type of piston head is the cheapest, cylinder wear considered — the solid head or one with bull ring and follower? To be opened by W. H. Marshall.

12. What can be done to thoroughly relieve the vacuum in a low-pressure cylinder or compound locomotive when drifting? To be opened by Angus Sinclair.

For subjects for committee reports for the 1899 meeting, the committee has prepared the following list:

1. A research laboratory, under the control of the American Railway Master Mechanics' Association.

2. Water purification and the use of a boiler purge.

3. Cast-iron *vs.* steel-tired wheels for passenger equipment, including cars, engine and tender trucks.

4. The advantages of the ton-mile basis for motive power statistics.

5. What is the best method of applying staybolts to locomotive boilers, including making the bolts and preparing the staybolt holes?

6. Is it advisable to have flanged tires on all the drivers of mogul, ten-wheel and consolidation engines? If so, with what clearance should they be set?

7. Is it good practice to make locomotive fire boxes with the crown and side sheets in one piece?

8. The use of nickeled steel in locomotive construction; its advantages and proper proportion of nickel.

By a vote of the Association at the 1897 meeting, Subject No. 1 was made one of the list for a committee to report on at the 1899 meeting. (See page 310 of the Proceedings of the 1897 meeting.)

The matter of continuing the Committee on High Steam Pressures, referred to this Committee at the Convention of 1898, was considered by the members of the Committee who were present, and they are of the opinion that this subject was thoroughly treated by the committee just discharged, and it can be more advantageously taken up again at some future time than at the present.

C. H. QUEREAU,
W. H. THOMAS,
PHILIP WALLIS,
*Committee.*

THE PRESIDENT: You have heard the recommendation of the Committee on Subjects, which, of course, is subject to revision by the Executive Committee. What is your pleasure to do with it?

MR. BRADLEY: I would like to ask to what extent the Executive Committee may revise it? You say it is subject to revision by the Executive Committee.

THE PRESIDENT: I believe the Constitution authorizes the Executive Committee to adopt such recommendations as it considers best. As I understand it, there are more subjects recommended than are finally adopted, and, more than that, it is almost always the case that there are subjects recommended by members on the floor, and these are all placed before the Executive Committee and they are revised to that extent. They never assume the authority to introduce new subjects, however, except as indicated by the membership.

MR. BRADLEY: The reason I asked the question was that I thought the Association might feel disposed to take up the question of workingmen's insurance. A number of roads have a kind of insurance with the men, and recent legislation has somewhat affected that, and it is a question whether some one of the railroad societies might not take up the question of workingmen's insurance and go through it and make an intelligent report. The difference in the practice in Europe and this country is very marked in that respect. You take an accident due to the trade; for example, say, a man has received an injury for which the machinery is not at fault, and for

which the company is in no way responsible. In this country, as soon as an employe is so injured, if it is established in court, he is left to himself. But in Europe such an injury as that is chargeable to the trade; that is, as an injury due to the trade or vocation the man is following, and all the governments in Europe have taken the question up and passed legislation on it, and there is a great deal of very interesting matter published on that question now in Germany, France and other countries, and the workingmen there are quite thoroughly protected, and all those cases are taken care of in that way, and it might lead to some good if some society of this kind would take that question up and have it discussed before some of these railroad meetings. I do not know whether the Master Mechanics' Association is the best association to take it up, but it seems to me it is a reasonable subject for them to take up.

MR. SINCLAIR: Mr. President, before that is even considered, I suggest that the Secretary read the preliminary of the Constitution of the Master Mechanics' Association.

THE PRESIDENT: I was going to call attention, Mr. Sinclair, to the fact that it is not a subject that this Association can deal with under the Constitution. It is not one that we are competent to deal with. We have executive officers in all our railroad systems whose duties are to outline such matters, and I do not think it is anything that should come before this Association, and there is where the prerogative of the Executive Committee comes in.

MR. WAITT: I move that the report of the Committee on Subjects be received and referred to the Executive Committee for further action.

The motion was seconded and carried.

THE PRESIDENT: Gentlemen, you of course recognize the fact that your Executive Committee this year assumed the authority, as was indicated by Mr. McConnell they would do, of changing the date of your meeting. We also prevailed upon the Master Car Builders' Association to change the date of theirs, and that change as made with them was recognized to the extent that this year they changed the by-laws so that the date of meeting is the second Wednesday instead of the second Tuesday in the month. Now, perhaps it is not necessary, as we have set them a pretty good example and probably the Executive Committee will go ahead the same as we did, and assume authority that is not delegated to it — but it has been suggested

that it would be well to get the approval of the Association of this change, in order to guide them or at least place the Executive Committee free to use their own judgment in the matter of setting the date for the next meeting.

MR. SETCHEL: Mr. President, I would move that the action of the Executive Committee in changing the date of the meeting of the previous year be indorsed, and that they are authorized to change the date of meeting for the year to come, as in their judgment is best suited to the interests of the Association. (Seconded.)

THE PRESIDENT: Before anyone undertakes to clinch that by any changes, I am glad it is made just as it is — that they are authorized to change the date, not that they are authorized to set it the same as they did this year. It is moved that the action of the Executive Committee of last year in changing the date be approved, and that the Executive Committee for the coming year be authorized to use their judgment in setting the date, making such changes as are necessary. As many as are in favor, will signify by saying "aye" — contrary minds, "no."

The motion was carried.

THE PRESIDENT: That finishes the reports of the committees, and next comes up the reading of papers, and discussion of questions propounded by members. This would really come under the heading of the noon hour discussion. We will pass that and take up routine and miscellaneous business. Has anyone anything to offer? If not, we will proceed to the election of officers.

MR ROBERT MILLER: Mr. Chairman, under the head of miscellaneous business, come, I think, suggestions of places of meeting. If it is in order, I would like to present a couple of letters from the executives of our city and State.

THE PRESIDENT: You will please listen to the letters that are to be presented by the gentleman on the place of the next meeting.

Mr. Miller read the following letters:

DETROIT, June 17, 1898.

*Mr. Robert Miller, City:*

DEAR SIR,— Inclosed I hand you invitations from Governor Pingree, Mayor Maybury and our League, which kindly present to the joint committee at Saratoga Springs next week. If there is anything further I can do in the matter kindly let me know. Please let me know where you will stop at Saratoga Springs and I will have several telegrams sent backing up our invitations.

Very truly yours, O. A. BIERCE, *Secretary.*

COMMONWEALTH OF MICHIGAN,
EXECUTIVE OFFICE,

LANSING, June 16, 1898.

*To the Joint Committee of the American Railway Master Mechanics' Association and the Master Car Builders' Association :*

GENTLEMEN,—The location of Detroit commends itself favorably to all who attend conventions on account of its accessibility by railway and steamship lines. It therefore gives me pleasure, as Michigan's Chief Executive, to extend to you a cordial invitation to hold your next joint convention in Detroit.

The natural advantages of Detroit as a convention city are excelled by none other. The climate, especially in the summer, is all that could be desired and the beautiful Detroit river affords the finest harbor in the world. It can be truthfully said that no other city in the country has the advantages and convention facilities of the beautiful City of the Straits. In the past half a dozen years Detroit has unconsciously made for herself the name of "Convention City," until today that title is applied to her by national bodies as they seek out available places for holding coming meetings. Her advantages are too numerous to mention in a letter, but among them are the excellent facilities for visiting the beautiful parks and Belle Isle; numerous water ways; rapid railway service and splendidly paved streets for carriage drives etc.

The citizens of Detroit and Michigan take especial pains to make visitors welcome, and I trust you will select Detroit as your next convention city.

Very respectfully, H. S. PINGREE,
*Governor.*

EXECUTIVE OFFICE — DETROIT, MICHIGAN,
WILLIAM C. MAYBURY, MAYOR.

June 15, 1898.

*To the Annual Convention of American Railway Mechanics and Master Car Builders :*

GENTLEMEN,— I desire to extend to you a most cordial greeting, and an invitation to meet in the city of Detroit at your next annual session.

You may be assured of a hearty welcome to our city, and your stay here will be made as pleasant as possible. Not only will you be welcomed by those directly interested in your business, but our citizens generally will be pleased to have in their midst a convention of so much dignity.

Hoping this invitation may be unanimously accepted, I am,

Cordially yours, WILLIAM C. MAYBURY,
*Mayor.*

DETROIT, June 17, 1898.

*To the Joint Committee of American Railway Master Mechanics' Association and Master Car Builders' Association :*

GENTLEMEN,— On behalf of the business interests of Detroit we extend to your Associations a most cordial invitation to hold their next annual gatherings in our midst.

You are probably aware of the convention advantages of Detroit, particularly

its superb location, river attractions, fine climate, and general modern improvements, but the warm hospitality of Detroiters to strangers you must witness to appreciate.

Our League will furnish a hall for meeting purposes, with commodious quarters for industrial display contiguous thereto, and do everything in its power to assist your local committee in the arrangements of details.

We assure delegates, members, officers and their friends a pleasant and profitable visit if you will meet with us. Respectfully,

DETROIT CONVENTION AND BUSINESS MEN'S LEAGUE,
J. C. HUTCHINS,
*Chairman.*

I would like to have these considered.

THE PRESIDENT: Gentlemen, there is no action to be taken in this matter except to place it in the hands of the Secretary to be placed before the Executive Committee for the joint committee. Are there any other nominations for place of holding the next meeting?

MR. SETCHEL: I move that the communications offered by Mr. Miller be referred to the Executive Committee.

The motion was carried.

THE PRESIDENT: The Secretary has another letter in the same line.

MR. CLOUD: It is a letter addressed to Mr. Leeds as President of the Association by the manager of the hotel at Lakewood:

LAKEWOOD, N. Y., June 17, 1898.

*Gentlemen of the Master Mechanics' Association, Congress Hall, Saratoga, New York:*

I take this means of calling your attention to this point as a desirable place for holding your next annual convention. Lakewood is now becoming quite a convention point on account of its accessibility, and the beauty and convenience of the place. The two hotels are now under one ownership and management, and make it possible to care for a very large number, all having similar accommodations and equal advantages.

The conditions at Lakewood are vastly different from what they were four or five years ago when your meeting was held here. At that time there was a sanitarium here, and while they took care of some of the members, were unable to care for many. The sanitarium has now been abandoned, the house has been remodeled and equipped, and has now an equal capacity with the Kent House. We will make the convention a rate of $3 per day, and will guarantee to have ample accommodations for meetings and exhibits. I shall be glad to give you any further information you may desire, and if you desire to visit Lakewood, think we can make it a very successful meeting for you. There are few places in the country where you can be more exclusive, if desired, than at Lakewood, and at the same time have a greater variety of attractions in the immediate vicinity. Since your former meeting

here, Celoron has been established, about two and one-half miles from here, and is one of the most attractive places of the kind in the country.

Hoping that you will give Lakewood due consideration at your meeting, I am,

Very truly yours, C. G. TRUSSELL.

On motion, the letter was referred to the Executive Committee.

MR. MORRIS: We do not want to appear selfish in this matter, but we all want you to feel that you are welcome to Old Point Comfort. Therefore, I would suggest that place to the Executive Committee. [Applause.]

MR. HUMPHREY: Mr. Chairman, I do not know that it is hardly worth while, but I desire to say that Denver, the gem of the Rockies, is still out there and that the Indians have been subdued. I will guarantee that there will be no danger of the Executive Committee being scalped if they come West. [Laughter.] For that reason I would urge that the Executive Committee bear in mind the members who have been traveling from the far West these many years and see if they cannot return the favor and give us a chance to stay at home just once. We would not ask it more than once in twenty years, and I would urge the Executive Committee to cast their eyes westward. [Applause.]

THE PRESIDENT: Are there any further suggestions? If not, we will proceed to the election of officers.

MR. HUMPHREY: I move you that we proceed to take the formal ballot for President of this Association.

THE PRESIDENT: I believe our Constitution provides for that — that the ballots are all formal. I appoint Messrs. Forsyth and Joughins as tellers. Now, gentlemen, please prepare your ballots for President of the Association.

The vote for President was as follows: For Robert Quayle, 46; for J. H. McConnell, 2; for A. M. Waitt, 1.

MR. PECK: I move that the Secretary cast the ballot of this convention for Mr. Quayle as President.

MR. MCCONNELL: Mr. President, I move that the election of Mr. Quayle be made unanimous.

The motion was seconded, and carried.

[Calls for Mr. Quayle.]

MR. QUAYLE: Mr. Chairman and Gentlemen,— I have not a prepared speech. I have not thought up anything. You know that I am very modest and do not like to say very much. Some persons

have said that they did not care anything about the office of President of an Association of this kind. But I just want to say to you that I am not one of that kind of fellows. [Applause.] I want to say to you that I take quite a little pride in having such an honor conferred upon me as the presidency of an association that has the ability within it which this Association has, an association of such dignity as this, one that is not only national in its scope but whose influence is felt the world over. I do not feel that while I shall be the presiding officer of this Association that the work of this Association shall devolve upon me at all, because there are so many here who in times past have stood shoulder to shoulder with the President and have helped the executive officers in every way to make this Association a success. This is not an association for selfish interests. It is an association for the expansion of the work, mechanically, of the railroads of this country, and I hope that you will stand by me just as well as you have by the other officers, and that I shall be able to guide this old ship of state so faithfully and so well that at the end of the year you may have it to say, "He hath done well." I thank you for the honor conferred upon me. [Applause.]

THE PRESIDENT: You will now prepare your ballots for First Vice-President.

The vote for First Vice-President was as follows: For J. H. McConnell, 45; for W. S. Morris, 2; for A. M. Waitt, 1; for Mr. Sinclair, 1.

MR. QUAYLE: I move that the vote for Mr. McConnell be made unanimous.

The motion was carried.

[Calls for Mr. McConnell.]

MR. MCCONNELL: Mr. Chairman and Gentlemen,—Some men would rather be right than President. There are others who would rather be President. [Laughter.] I wish to say that the long list of illustrious names that have preceded me in this office will be an inspiration to do my very best for the Association. [Applause.]

THE PRESIDENT: You will now proceed to cast your ballots for the Second Vice-President.

The vote for Second Vice-President was as follows: For W. S. Morris, 46; for A. L. Humphrey, 1; for G. R. Henderson, 1; for W. T. Smith, 1.

MR. McINTOSH: I move that the election of Mr. Morris be made unanimous.

The motion was carried.

[Mr. Morris was called for.]

MR. MORRIS: I am very thankful indeed that you can distinguish the difference between Morris and Henderson this time. [Laughter.] I appreciate very much indeed your kindness and I shall endeavor to do my whole duty as Second Vice-President. I thank you again.

THE PRESIDENT: Now, please prepare your ballots for the Third Vice-President.

The vote for Third Vice-President was as follows: Total vote 49; for A. M. Waitt, 23; for G. R. Joughins, 6; for A. L. Humphrey, 6; for A. E. Manchester, 5; for A. E. Mitchell, 2; for G. R. Henderson, 1; for David Brown, 1; for T. B. Purves, Jr., 5.

THE PRESIDENT: There were 49 votes cast of which 23 were for Mr. Waitt and 26 scattering. Consequently there is no election and we will take another vote.

The second ballot for Third Vice-President was as follows: Total number of votes cast, 49; for A. M. Waitt, 38; for A. L. Humphrey, 5; for G. R. Joughins, 3; for A. E. Manchester, 2; for T. B. Purves, Jr., 1.

MR. HUMPHREY: I move you that the election of Mr. Waitt be made unanimous.

The motion was seconded and carried.

[Mr. Waitt was called for.]

MR. WAITT: Mr. President and members of the Association, I assure you the action which you have taken is one that is a total surprise to me. I assure you that I fully appreciate the high honor that you have conferred upon me and the expression of broadness and liberality of the American Railway Master Mechanics' Association. I believe that the spirit that is shown by this Association will go far toward bringing about a happy and successful merging of the two Associations in the near future. [Applause.] I believe in it heartily, and in connection with any duties that are imposed upon me here I shall try to bring that about. I thank you, gentlemen. [Applause.]

THE PRESIDENT: Mr. Waitt, will you take a seat on the platform? Gentlemen, we have the election of our Treasurer before us. Please prepare your ballots for the election of Treasurer.

The vote for Treasurer was as follows: For J. N. Barr, 31; for Angus Sinclair, 15; for J. H. Setchel, 1.

MR. WAITT: I move that vote for Mr. Barr be made unanimous as Treasurer of this Association.

The motion was seconded, and carried.

THE PRESIDENT: Gentlemen, that completes the regular order of business, but it leaves a number of subjects under the topical discussions that have not been taken up. I would ask your pleasure in the matter as to whether the discussion of those topical subjects shall be waived or whether they shall be taken up at this time before adjourning.

MR. PECK: On account of the rainstorm, and it being nearly 12 o'clock and we cannot hear anything, I move that we dispense with the topical discussions and continue the same subjects for next year. [Seconded.]

THE PRESIDENT: I am very sorry that this has to be carried over, but at the same time I do not see how we can avoid it, and we will put the vote on the motion.

The motion was carried.

THE PRESIDENT: As adjournment comes in regular order, I would like to entertain a motion to adjourn.

MR. BRIGGS: Mr. President, before adjourning, I move as a compliment to our retiring President that we extend our thanks to him for his efficiency and untiring energy as President for the past year. [Seconded.]

MR. QUAYLE: Gentlemen of the convention, you have heard the motion to the effect that a vote of thanks be tendered to the retiring President for his arduous and well-conducted work in this Association during the past year. All in favor of that will please——

MR. SETCHEL: One moment, please. The President has remarked that we should place no officer in line who would not be suitable for promotion to the Presidency, and I want to disabuse his mind if he thinks that he became President simply because he was in the line of promotion. That was not it at all. We put him in the President's chair because we thought he was competent to fill the place and because we wanted to reward a man who had been faithful in every place in which this Association had put him, and not because he was in line. As evidence of this I may refer to the fact that once before in the history of the Association a man arrived at the first

Vice-Presidency and was turned down. Now I want to warn the First Vice-President that that thing may occur again, and also the Second Vice-President and the Third. It does not at all follow that because you are elected to the Vice-Presidency that you are going to be President. We expect you to do your duty and take an interest in these things, and that is the reason that you became President, sir.

MR. McCONNELL: Mr. Chairman, in accepting the office of First Vice-President, I assumed all the risks and responsibilities connected with it. [Laughter and Applause.]

There were calls for the question.

MR. QUAYLE: All in favor of the motion before the house will manifest it by rising to their feet. It is unanimous, Mr. President.

Mr. Leeds, in response to calls for a speech, said: Gentlemen, first and foremost I want to file a disclaimer. Our present President spoke of the arduous duties that had devolved upon me. Allow me to say that my lieutenants have almost entirely relieved me of those arduous duties, and the convention, since we have been here, has been kind enough to further relieve me to such an extent that there has been nothing arduous in the position. I want to impress upon you that I fully appreciate the honor that has been conferred upon me by such a body of men. I thank you kindly and I will ask only one thing more, and that is that you join me in reiterating a special vote of thanks to Professor Goss, who has made the innovation that we have introduced such an admirable success. I ask you to join me in such a vote by rising to your feet.

All the members present arose.

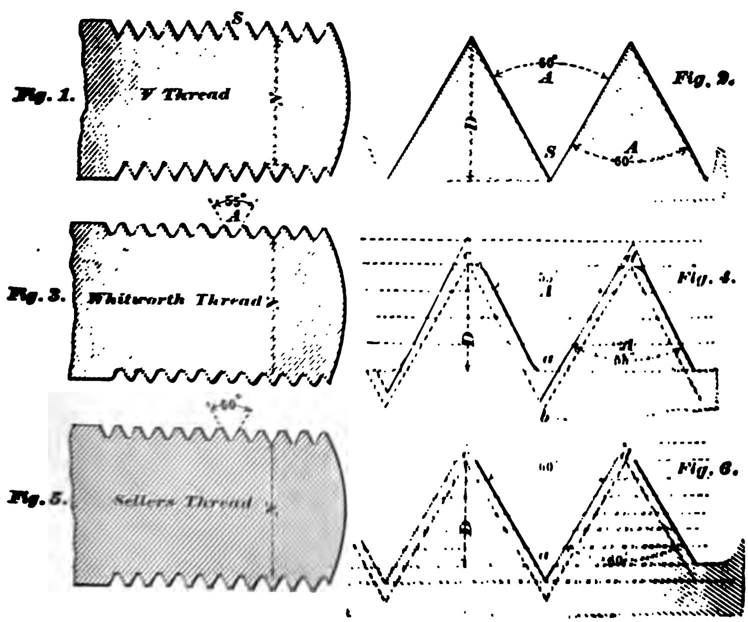
MR. LEEDS: Gentlemen, I thank you for the honor you conferred upon me, and for the good wishes that go with my retirement. [Applause.]

On motion of Mr. Briggs, the convention then adjourned.

# STANDARDS ADOPTED BY THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

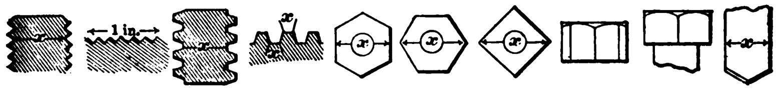
## SCREW THREADS.

At the Third Annual Convention the report of a Committee recommending the United States standard screw thread was adopted. Annexed are the forms and dimensions of the threads in question.




SCREW THREADS. SELLERS' STANDARD.

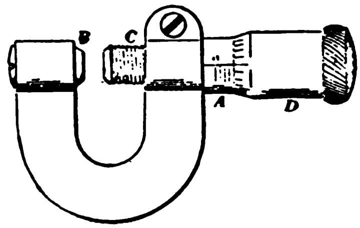
The Association at the Twenty-fifth Annual Convention adopted the United States standard sizes of nuts and bolt heads, particulars of which are given below:




| Diameter of Screw. | Threads per inch. | Diameter at Root of Thread. | Width of Flat. | Short Diameter of Hexagon or Square. | Long Diameter Hexagon. | Long Diameter Square. | Thickness Nuts. | Thickness Heads. | Tap Dri 1. |
|---|---|---|---|---|---|---|---|---|---|
| 1/4 | 20 | .185 | .0062 | 1/2 | 37/64 | 7/10 | 1/4 | 1/4 | 3/16 |
| 5/16 | 18 | .240 | .0074 | 19/32 | 11/16 | [illegible] | 5/16 | 19/64 | 1/4 |
| 3/8 | 16 | .294 | .0078 | 11/16 | 51/64 | 63/64 | 3/8 | 11/32 | 5/16 |
| 7/16 | 14 | .344 | .0089 | 25/32 | 9/10 | 1 7/64 | 7/16 | 25/64 | 23/64 |
| 1/2 | 13 | .400 | .0096 | 7/8 | 1 | 1 15/64 | 1/2 | 7/16 | 13/32 |
| 9/16 | 12 | .454 | .0104 | 31/32 | 1 1/8 | 1 23/64 | 9/16 | 31/64 | 15/32 |
| 5/8 | 11 | .507 | .0113 | 1 1/16 | 1 7/32 | 1 1/2 | 5/8 | 17/32 | 17/32 |
| 3/4 | 10 | .620 | .0125 | 1 1/4 | 1 7/16 | 1 49/64 | 3/4 | 5/8 | 5/8 |
| 7/8 | 9 | .731 | .0138 | 1 7/16 | 1 21/32 | 2 1/32 | 7/8 | 23/32 | 3/4 |
| 1 | 8 | .837 | .0156 | 1 5/8 | 1 7/8 | 2 19/64 | 1 | 13/16 | 27/32 |
| 1 1/8 | 7 | .940 | .0178 | 1 13/16 | 2 3/32 | 2 9/16 | 1 1/8 | 29/32 | 31/32 |
| 1 1/4 | 7 | 1.065 | .0178 | 2 | 2 5/16 | 2 53/64 | 1 1/4 | 1 | 1 3/32 |
| 1 3/8 | 6 | 1.160 | .0208 | 2 3/16 | 2 17/32 | 3 3/32 | 1 3/8 | 1 3/32 | 1 3/16 |
| 1 1/2 | 6 | 1.284 | .0208 | 2 3/8 | 2 3/4 | 3 23/64 | 1 1/2 | 1 3/16 | 1 9/32 |
| 1 5/8 | 5 1/2 | 1.389 | .0227 | 2 9/16 | 2 31/32 | 3 5/8 | 1 5/8 | 1 9/32 | 1 13/32 |
| 1 3/4 | 5 | 1.491 | .0250 | 2 3/4 | 3 3/16 | 3 57/64 | 1 3/4 | 1 3/8 | 1 1/2 |
| 1 7/8 | 5 | 1.616 | .0250 | 2 15/16 | 3 13/32 | 4 5/32 | 1 7/8 | 1 15/32 | 1 5/8 |
| 2 | 4 1/2 | 1.712 | .0277 | 3 1/8 | 3 5/8 | 4 27/64 | 2 | 1 9/16 | 1 3/4 |
| 2 1/4 | 4 1/2 | 1.962 | .0277 | 3 1/2 | 4 1/16 | 4 61/64 | 2 1/4 | 1 3/4 | 1 31/32 |
| 2 1/2 | 4 | 2.176 | .0312 | 3 7/8 | 4 1/2 | 5 31/64 | 2 1/2 | 1 15/16 | 2 3/16 |
| 2 3/4 | 4 | 2.426 | .0312 | 4 1/4 | 4 29/32 | 6 | 2 3/4 | 2 1/8 | 2 7/16 |
| 3 | 3 1/2 | 2.629 | .0357 | 4 5/8 | 5 3/8 | 6 17/32 | 3 | 2 5/16 | 2 5/8 |
| 3 1/4 | 3 1/2 | 2.879 | .0357 | 5 | 5 13/16 | 7 1/16 | 3 1/4 | 2 1/2 | 2 29/32 |
| 3 1/2 | 3 1/4 | 3.100 | .0384 | 5 3/8 | 6 7/64 | 7 39/64 | 3 1/2 | 2 11/16 | 3 1/32 |
| 3 3/4 | 3 | 3.317 | .0413 | 5 3/4 | 6 21/32 | 8 1/8 | 3 3/4 | 2 7/8 | 3 11/32 |
| 4 | 3 | 3.567 | .0413 | 6 1/8 | 7 3/32 | 8 41/64 | 4 | 3 1/16 | 3 19/32 |
| 4 1/4 | 2 7/8 | 3.798 | .0435 | 6 1/2 | 7 9/16 | 9 3/16 | 4 1/4 | 3 1/4 | 3 13/16 |
| 4 1/2 | 2 3/4 | 4.028 | .0454 | 6 7/8 | 7 31/32 | 9 3/4 | 4 1/2 | 3 7/16 | 4 1/32 |
| 4 3/4 | 2 5/8 | 4.256 | .0476 | 7 1/4 | 8 13/32 | 10 1/4 | 4 3/4 | 3 5/8 | 4 9/32 |
| 5 | 2 1/2 | 4.480 | .0500 | 7 5/8 | 8 27/32 | 10 49/64 | 5 | 3 13/16 | 4 1/2 |
| 5 1/4 | 2 1/2 | 4.730 | .0500 | 8 | 9 9/32 | 11 23/64 | 5 1/4 | 4 | 4 3/4 |
| 5 1/2 | 2 3/8 | 4.953 | .0526 | 8 3/8 | 9 23/32 | 11 7/8 | 5 1/2 | 4 3/16 | 4 31/32 |
| 5 3/4 | 2 3/8 | 5.203 | .0526 | 8 3/4 | 10 5/32 | 12 3/8 | 5 3/4 | 4 3/8 | 5 7/32 |
| 6 | 2 1/4 | 5.423 | .0555 | 9 1/8 | 10 19/32 | 12 15/16 | 6 | 4 9/16 | 5 7/16 |

SHEET METAL GAUGE.

At the Fifteenth Annual Convention the Brown & Sharpe micrometer gauge shown below was adopted as standard for the measurement of sheet metal.



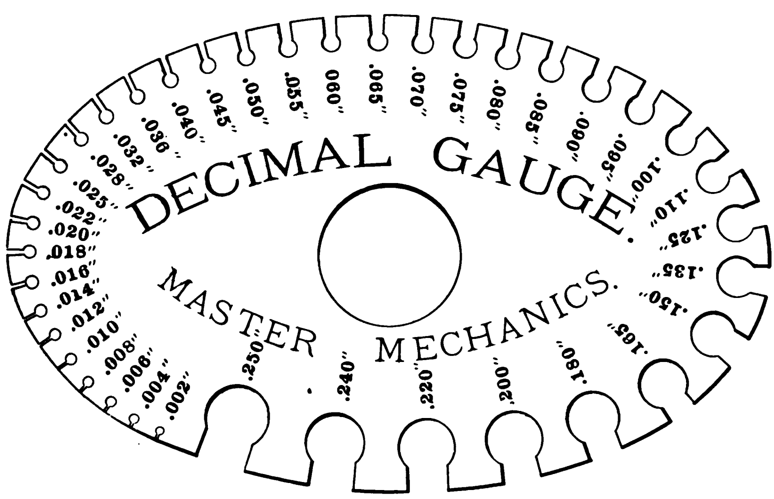

DECIMAL GAUGE.

At the Twenty-eighth Annual Convention the following was adopted as standard decimal gauge:

1st. The micrometer caliper should be used for laboratory and toolroom work, and in the shop when specially desired.

2d. The solid notch gauge should be used for general shop purposes.

3d. The form of this gauge shall be an ellipse whose major axis is 4 inches, the minor axis 2.5 inches, and the thickness .1 inch, with a central hole .75 inch in diameter.



4th. The notches in this gauge shall be as follows:

| | | | |
|---|---|---|---|
| .002″ | .022″ | .060″ | .110″ |
| .004″ | .025″ | .065″ | .125″ |
| .006″ | .028″ | .070″ | .135″ |
| .008″ | .032″ | .075″ | .150″ |
| .010″ | .036″ | .080″ | .165″ |
| .012″ | .040″ | .085″ | .180″ |
| .014″ | .045″ | .090″ | .200″ |
| .016″ | .050″ | .095″ | .220″ |
| .018″ | .055″ | .100″ | .240″ |
| .020″ | ..... | ..... | .250″ |

5th. All notches to be marked as in the above list.

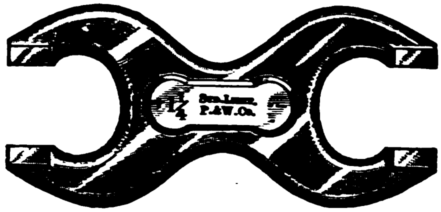
6th. The gauge must be plainly stamped with the words "Decimal Gauge" in capital letters .2 inch high, and below this the words "Master Mechanics."

7th. In ordering material, the term gauge shall *not* be used, but the thickness ordered by writing the decimal as in above list. For sizes over ¼ inch, the ordinary common fractions may be used.

### LIMIT GAUGES.

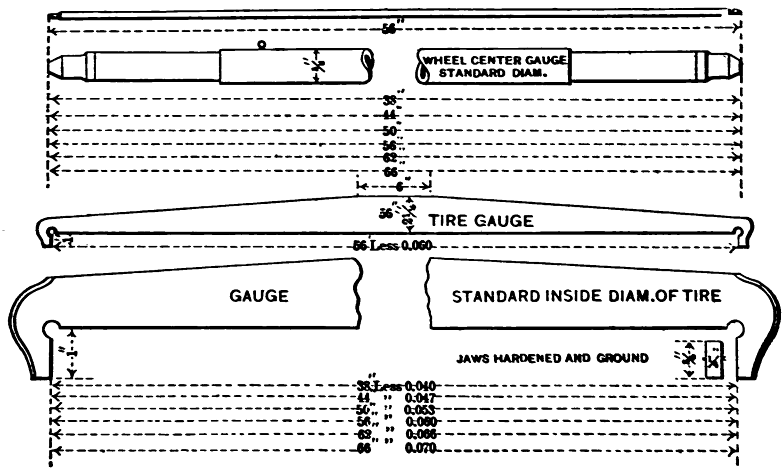
At the Seventeenth Annual Convention the Pratt & Whitney limit gauges for round iron, illustrated on this and following page, were adopted. The sizes are as follows:

| Nominal Diameter. Of Iron. Inches. | Large Size, End. Inches. | Small Size, End. Inches. | Total Variation. Inches. |
|---|---|---|---|
| $\frac{1}{4}$ | .2550 | .2450 | .010 |
| $\frac{5}{16}$ | .3180 | .3070 | .011 |
| $\frac{3}{8}$ | .3810 | .3690 | .012 |
| $\frac{7}{16}$ | .4440 | .4310 | .013 |
| $\frac{1}{2}$ | .5070 | .4930 | .014 |
| $\frac{9}{16}$ | .5700 | .5550 | .015 |
| $\frac{5}{8}$ | .6330 | .6170 | .016 |
| $\frac{3}{4}$ | .7585 | .7415 | .017 |
| $\frac{7}{8}$ | .8840 | .8660 | .018 |
| 1 | 1.0095 | .9905 | .019 |
| 1 $\frac{1}{8}$ | 1.1350 | 1.1150 | .020 |
| 1 $\frac{1}{4}$ | 1.2605 | 1.2395 | .021 |



DRIVING-WHEEL CENTERS AND SIZES OF TIRES.

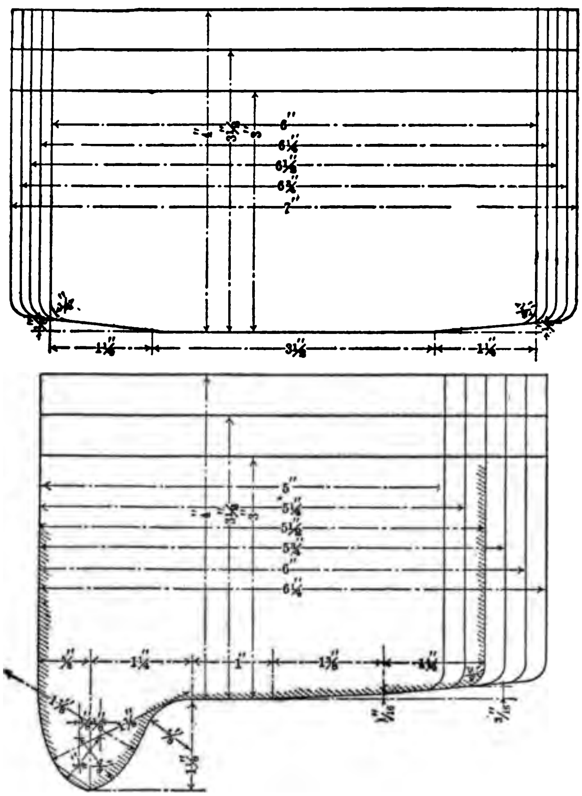
At the Nineteenth Annual Convention the report of a committee was adopted which recommended driving-wheel centers to be made 38, 44, 50, 56, 62 or 66 inches diameter. At the Twentieth Annual Convention the recommendations of a committee were adopted, making tire gauges manufactured by Messrs. Pratt & Whitney, Hartford, Connecticut, and here illustrated, standards of the Association. The sizes and the allowance for shrinkage are as follows:




At the Twenty-sixth Annual Convention the following sizes were adopted as standard for large driving wheels: 70, 74, 78, 82, 86 and 90 inches.

## STANDARD FORMS OF TIRES.

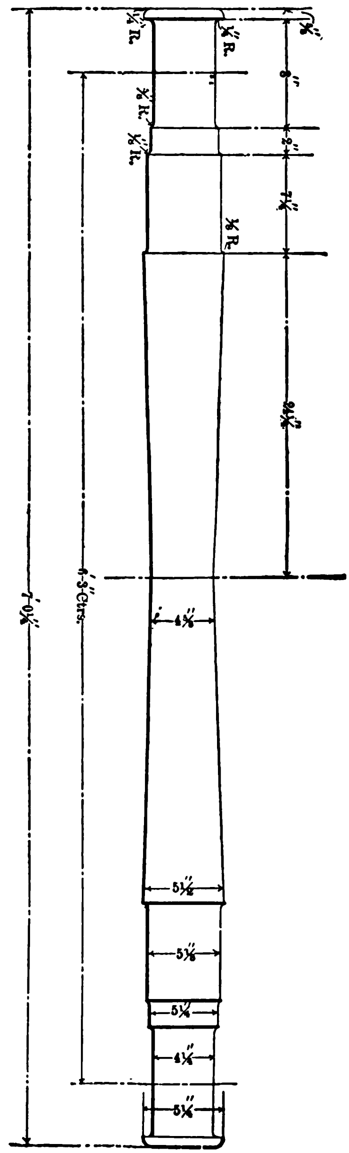
At the Twenty-sixth Annual Convention the forms of tires shown in the annexed engraving were adopted as standard. Railroad companies ordering tires will save time by specifying these forms.



At the Twenty-ninth Annual Convention a minimum thickness of 1 inc' flanges of engine and truck wheels was adopted as standard practice; detei to be made by M. C. B. flange thickness gauge. See Proceedings for 1896

### AXLE FOR HEAVY TENDERS.

The accompanying illustration shows the dimensions of the axles for heavy tenders recommended by a committee of the Association.



METHOD OF CONDUCTING LOCOMOTIVE TESTS.

Adopted at the Twenty-seventh Annual Convention; full details, page 166, Twenty-seventh Annual Report.

BOILER STEEL SPECIFICATIONS.

Adopted at Twenty-seventh Annual Convention; full details, page 68, Twenty-seventh Annual Report.

SPECIFICATIONS AND TESTS FOR LOCOMOTIVE IRON BOILER TUBES, EXTRA QUALITY.

Adopted at Twenty-eighth Annual Convention.

*Material.*

Tubes to be made of knobbled hammered charcoal iron and lap-welded.

*Dimensions and Weights.*

Tubes 2 inches, outside diameter.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| .095 | inch | thick | and | weight | at least | 1.91 | lbs. | per foot. |
| .110 | " | " | " | " | | 2.19 | " | " |
| .125 | " | " | " | " | | 2.47 | " | " |
| .135 | " | " | " | " | | 2.65 | " | " |

Tubes 2¼ inches, outside diameter.

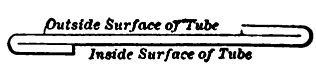
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| .095 | inch | thick | and | weight | at least | 2.16 | lbs. | per foot. |
| .110 | " | " | " | " | | 2.48 | " | " |
| .125 | " | " | " | " | | 2.80 | " | " |
| .135 | " | " | " | " | | 3.01 | " | " |

*Surface Inspection.*

Tubes must have a smooth surface, free from all laminations, cracks, blisters, pits and imperfect welds. They must also be free from bends, kinks and buckles — signs of unequal contraction in cooling or injury in manipulation — and must be of uniform thickness throughout, except at weld, where .015 inch additional will be allowed, perfectly round and cut to exact length ordered.

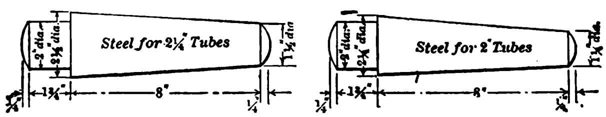
*Physical Tests.*

1. Strips one-half inch in width by six inches in length, planed lengthwise from tubes, after being heated to a cherry red and dipped in water at 80 degrees Fahrenheit, shall bend in opposite directions at each end as shown in sketch below, without showing cracks or flaws; and when nicked and broken these must show a fracture wholly fibrous, or a test in a testing machine may be substituted for this.



2. Sections of tubes 12 inches long — five inches of which shall be heated to a *bright cherry red* in daylight — when placed in a vertical position, and a smooth-turned tapered steel pin at a *blue heat* is driven in, by "lap" blows with a 10-pound sledge hammer, must stretch to one and one-eighth times their original diameter without split or crack. One tube to be tested, as required in paragraphs 1 and 2, in each lot of 250 tubes or less.

The sketches below show dimensions of steel pins to be used for 2-inch and 2¼-inch O. D. tubes.




3. Tubes must expand, turn over tube plate and bend down without flaw, crack or opening at weld.

*Hydraulic Test.*

Each tube must be subjected, by the manufacturer, to an internal pressure of 500 pounds to the square inch.

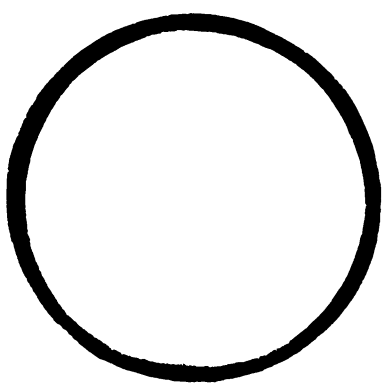
*Etching Tests.*

In case of doubt as to the quality of material, the following tests shall be used namely:

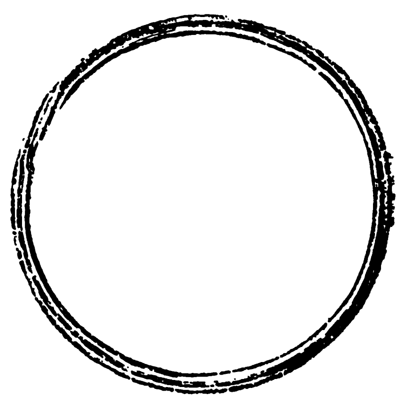
A section of tube turned or ground to a perfectly true surface, polished with fine emery paper, and free from dirt and grease, to be suspended in a bath of

| | |
|---|---|
| Water........................ | 9 parts. |
| Sulphuric acid................. | 3 " |
| Muriatic " ................. | 1 " |

The bath should be prepared by placing the water in a porcelain dish, adding the sulphuric acid and then the muriatic acid. Chemical action is allowed to con-



**Steel.**



**Charcoal Iron.**

tinue until the soft parts are sufficiently dissolved so that an iron tube will show a more or less finely ridged surface, with the weld very distinct; a steel tube will present a homogeneous surface.

*General Requirements.*

Each tube must be plainly stenciled "Knobbled Hammered Charcoal Iron" and "Tested to 500 Pounds," and tubes must be so invoiced. Each tube must also be subjected to careful surface inspection, as provided for above; and those measuring one sixty-fourth of an inch over or under the diameter ordered shall be rejected.

Muskegon Railway. When the road was finally sold to the Grand Trunk Railway, he came to Louisville, in June, 1888, with the same parties, and assumed the position of Master Mechanic of the Louisville, Henderson & St. Louis Railway, which position he held until his death.

Mr. Ferry became a member of this Association in 1889, and was a member up to the time of his death.

He was an affectionate father, and an honorable and upright citizen. His wife and six children survive him.

J. G. CLIFFORD.

## WILLIAM LANNAN.

William Lannan was born in Baltimore, Maryland, December 21, 1836. He lived in that city until he was twenty years of age. He served an apprenticeship to the machinist trade at the Mount Clare Shops of the Baltimore & Ohio Railroad. When twenty years of age he entered the service of the United States Navy as oiler, making his first trip on the Steamship Minnesota, under Captain Dupont. On this voyage they carried the Hon. W. B. Reed, the first Minister sent by the United States to China. During the Civil War he was promoted to Third Assistant Engineer, September, 1862, and served in that capacity on several vessels. He was on one of the vessels that composed Admiral Farragut's fleet on the Mississippi. At the time of receiving his honorable discharge in September, 1865, he was Second Assistant Engineer. He then became First Assistant Engineer on a steamship in the Savannah Line. Becoming tired of a sea life, he returned to his trade and entered the shops of the Northern Central Railway, at Baltimore, and in 1869 went to the Western Maryland Railroad at Union Bridge, Maryland, and in 1872 he became Master of Machinery of that road. In 1877 he was appointed Chief Engineer of the United States House of Representatives and continued in that position until his death, which occurred July 3, 1897.

Mr. Lannan became a member of the Master Mechanics' Association in 1873. At the meeting held at Alexandria Bay, June 17, 18 and 19, 1895, he was elected an Honorary Member, having been a member of the Association at that time for twenty-two years. Mr. Lannan always took great interest in the proceedings of the convention, although not often able to attend, owing to duties that demanded his attention in Washington.

He was upright and honest in his dealings with his fellow-men and endeared himself to all with whom he came in contact.

W. H. THOMAS.

## JOHN HURST.

John Hurst, the well-known Master Mechanic of the Salt Lake & Ogden Railroad, who died at Salt Lake City, on November 16, 1897, of typhoid fever, was born in 1855, being forty-two years of age at the time of his death. He leaves behind a wife and three children.

Mr. Hurst was recognized as one of the ablest men of the section in which he labored. He was possessed of a very active intellect, and many convenient shop tools owe their existence to him. Mr. Hurst was the inventor of the air brake which bears his name, and which is now being successfully operated on many of the mountain roads in the West.

In the death of Mr. Hurst, the city of Salt Lake has lost a useful and highly respected citizen.

JOHN HICKEY.

## F. J. FERRY.

Mr. F. J. Ferry, Master Mechanic of the Louisville, Henderson & St. Louis Railway, died November 4, 1897, at his home in Cloverport, Kentucky.

He was born in Villenovia, Chautauqua County, New York, September 5, 1845, At the age of fourteen he went to work in the Dunkirk Locomotive Works, and in 1861 left there to enter the Union Army, Company D, 3d New York Regiment, at the age of seventeen, and served some two years with the Army of the Potomac, under General McClellan, participating in the engagements at Yorktown; Williamsburg and Seven Pines, and was discharged in 1863 on account of sickness. He then came to Eastern Kentucky and worked at the iron furnaces in Greenup County. and vicinity for a period of about three years, during which time he married Miss Nacy Fouche Stone. He afterward moved to Fort Wayne, Indiana, where his uncle was foreman of the Pennsylvania Railroad Company's roundhouse, and worked under him in the shops. From there he went on the road as fireman, and was promoted to the position of engineer in 1866, and ran on the P. F. W. & C. and G. R. I. roads for a number of years, but, owing to failing health, was compelled to give this up. He went to Muskegon, Michigan, in 1887, and engaged as Master Mechanic with W. V. McCracken & Co., who were then building the Toledo, Saginaw &

Muskegon Railway. When the road was finally sold to the Grand Trunk Railway, he came to Louisville, in June, 1888, with the same parties, and assumed the position of Master Mechanic of the Louisville, Henderson & St. Louis Railway, which position he held until his death.

Mr. Ferry became a member of this Association in 1889, and was a member up to the time of his death.

He was an affectionate father, and an honorable and upright citizen. His wife and six children survive him.

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[illegible]

## DANIEL GORDON MOTT.

Daniel Gordon Mott became a member of the American Railway Master Mechanics' Association in 1891. His untimely death, January 16, 1898, as well as the main facts of his life are perhaps best recorded in the following General Order of the Panama Railroad Company, which was issued at Colon, Columbia, on January 20, 1898:

OFFICE PANAMA RAILROAD COMPANY.

GENERAL ORDER NO. 55.

1. It has become the sad duty of the Superintendent of the Panama Railroad Co. to make official announcement of the death of

MR. DANIEL GORDON MOTT,

MASTER MECHANIC,

of the Panama Railroad Co., who lost his life in the harbor of Colon on Sunday, January 16, 1898.

Daniel Gordon Mott was born in Campbellton, New Brunswick, Canada, March 29, 1863. He was a machinist apprentice in Canada from 1877 to 1880. He was machinist and foreman in Boston and thereabouts from 1880 to 1885. In April, 1885, he entered the service of the Panama Railroad Co., and filled the various positions of timekeeper, machinist, locomotive engineer and acting master mechanic, and was appointed Master Mechanic November, 1890.

The official association of the present Superintendent of the Panama Railroad with Mr. Mott began November 27, 1895. From that day, during the period of which it is practicable to speak from personal knowledge, his services have been invaluable. His natural capacity, which was extraordinary, his long service with the company, and his close and painstaking scrutiny of everything pertaining to its interests, in every department under him, fitted him to be, as he was, an administrative officer of preëminent ability, whose advice and coöperation was always to be depended upon in any and every emergency. It is not too much to say that in Daniel Gordon Mott the Panama Railroad Co. has lost an officer than whom any other officer on the Isthmus, without exception, could better have been spared. His loss is irreparable.

2. Memorial services will be held in Christ Church and the Wesleyan Chapel in Colon on Sunday, January 23, at 3:30 P.M.

3. All flags will be placed half-mast until after the Memorial Services, and the engines of the company will be draped in mourning for thirty days.

J. R. SHALER,
*Superintendent.*

## JOHN MULLIGAN.

John Mulligan, the late President of the Connecticut River Railroad, was born in Hartford, Connecticut, January 12, 1820, and he died at Springfield, Massachusetts, February 22, 1898. Mr. Mulligan was one of the charter members of this Association, and was, at the time of his death, an honorary member.

Mr. Mulligan was born with a talent for mechanical work. At fifteen years of age he was apprenticed as a machinist, the trade of his father. A part of his apprenticeship was served in the shop with William Norris, the locomotive builder, of Philadelphia. In 1841 he was employed as engineer on a freight boat running between Hartford and Willimansett. In 1843 he became a locomotive engineer, and continued at the throttle until 1852, at which time he received the appointment of Master Mechanic of the Connecticut River Railroad shops, then located at Northampton, continuing his residence at Springfield, Massachusetts, where, in 1861, new shops were built.

In August, 1868, Mr. Mulligan was appointed acting superintendent, and at the annual meeting in January, 1869, he was formally appointed Superintendent, and for three years following combined with it the office of Master Mechanic. These were busy years, for the road during this time was double-tracked, and the Easthampton branch was built.

In 1872 Mr. Mulligan was relieved of the duties of Master Mechanic, and from 1869 to 1890 held the position of Superintendent. In 1890 he was chosen a director of the road, and soon after was elected President.

It was not his practice to neglect a single detail that would go to make up a modern railroad. This faithfulness, combined with natural ability, and a familiarity with all branches of railroad service, which was of great assistance to him, was the principal factor in his success in railroad life.

Mr. Mulligan took an active interest in city and public affairs. He served two years as alderman, and five years in the common council. He was for many years trustee of the Hampden Savings Bank, and for several years its president. He was also a director of the Chapin National Bank. In his public service he was as conscientious as in his business, and gave it his best thought and effort. He did not aspire to political honors; had he done so, with his genial nature, which made him friends everywhere, he could have been mayor of his city.

Mr. Mulligan was married in 1845 to Lydia Ann, daughter of Hastings Bridges. She died in 1887. He leaves two children: Charles Henry, superintendent of the Hawkins Foundry, and Mary Henrietta, wife of James T. Abbe, both of Springfield.

In the death of John Mulligan there passed from New England one of the pioneers of railroad life — a man who gradually rose from the humble position of

engineer to the office of president of an important railroad corporation. He was a man with a strong personality, and, although a self-made man in every sense of the word, his success never in any way put him beyond the approach of the humblest of his former comrades, and all of his associates will concur in the sentiment expressed by one of the shop hands as he passed one day: "There is a man who is every inch as 'white' as his snowy hair."

C. E. FULLER.

## P. H. SCHREIBER.

Peter Harrison Schreiber was born in White Hall Township, Lehigh County, Pennsylvania, on July 24, 1851, and died of apoplexy at Chattanooga, Tennessee, on September 9, 1897.

He first went to work at the age of sixteen for the Stanton Manufacturing Co., where he served two years as a machinist apprentice; then took service with the Central Railroad of New Jersey as car inspector, at which he worked three years. After leaving the Central Railroad of New Jersey he was out of the railroad business for several months, working for a firm in Columbus, Ohio, but again went to work for a railroad when he started in with the C. C. C. & St. L. R'y at Delaware, Ohio, at which place he worked in the shops about eight years and on the road as fireman about two years. He started to work for the C. N. O. & T. P. R'y in 1882, and continued with said company until the time of his death, beginning as machinist and holding the positions of roundhouse foreman, locomotive engineer, road foreman of engines and Master Mechanic in the order named, being employed in the latter capacity when he died.

Mr. Schreiber was a man who gave his closest attention to his business and the welfare of the company for which he worked, and by his actions obtained the respect and regard of all with whom he became associated, both in a business capacity and socially. He became a member of the American Railway Master Mechanics' Association in 1891. At the time of his death he was a member of the order of B. of L. E., No. 198; also a Mason, being a Knight Templar and member of the Mystic Shrine.

His wife survives him.

J. P. McCUEN.

# SUBSCRIPTIONS TO PRINTING FUND.

| | |
|---|---|
| Alabama Great Southern | $ 3.00 |
| Atchison, Topeka & Santa Fe | 15.00 |
| Atlantic Coast Line | 13.50 |
| Baldwin Locomotive Works | 25.00 |
| Boston & Maine | 10.50 |
| Baltimore & Ohio South-Western | 10.50 |
| Burlington, Cedar Rapids & Northern | 10.50 |
| Buffalo, Rochester & Pittsburgh | 12.00 |
| Burlington & Missouri River | 12.00 |
| Cleveland, Lorain & Wheeling | 4.50 |
| Columbus, Sandusky & Hocking | 1.50 |
| Chicago, Burlington & Quincy | 10.50 |
| Chicago & Eastern Illinois | 6 00 |
| Chicago Great Western | 9.00 |
| Chicago, Lake Shore & Eastern | 3.00 |
| Chesapeake & Ohio | 15.00 |
| Cincinnati, New Orleans & Texas Pacific | 6.00 |
| Central Vermont | 9.00 |
| Canadian Pacific | 6.00 |
| Chicago, St. Paul, Minneapolis & Omaha | 7.50 |
| Chicago & North-Western | 15.00 |
| Columbus, Hocking Valley & Toledo | 4.50 |
| Cape Fear & Yadkin Valley | 3.00 |
| Cleveland, Cincinnati, Chicago & St. Louis | 15.00 |
| Cincinnati, Hamilton & Dayton | 10.50 |
| Coster, E. L | 15.00 |
| Chicago, Burlington & Northern | 9.00 |
| Chicago, Hammond & Western | 3.00 |
| Colorado Midland | 9.00 |
| Chicago, Milwaukee & St. Paul | 15.00 |
| Canada Atlantic | 3.00 |
| Delaware, Lackawanna & Western | 9.00 |
| Denver & Rio Grande | 7.50 |
| Delaware & Hudson Canal Co | 9.00 |
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| Erie | 15.00 |
| Fall Brook | 9.00 |
| Florida East Coast | 4.50 |
| Fitchburg | 10.50 |
| Fort Worth & Denver City | 1.50 |

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|---|---|
| Grand Rapids & Indiana | $ 6.00 |
| Georgia | 7.50 |
| Grand Trunk | 12.00 |
| Great Northern | 7.50 |
| Hannibal & St. Joseph | 9.00 |
| Iowa Central | 3.00 |
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| Lehigh Valley | 10.00 |
| Louisville & Nashville | 10.50 |
| Long Island | 3.00 |
| Lake Erie & Western | 6.00 |
| Maine Central | 9.00 |
| Michigan Central | 9.00 |
| Missouri, Kansas & Texas | 9.00 |
| Missouri Pacific | 7.50 |
| Minneapolis, St. Paul & Sault Ste. Marie | 10.50 |
| Nolan, J. P. | 3.00 |
| New York, Chicago & St. Louis | 10.50 |
| New York, Ontario & Western | 10.50 |
| New Orleans & North-Eastern | 1.65 |
| Norfolk & Western | 15.00 |
| Oregon Short Line | 3.00 |
| Pennsylvania Company | 12.00 |
| Peoria & Eastern | 1.50 |
| Portland Locomotive Works | 7.50 |
| Pennsylvania | 36.00 |
| Philadelphia, Wilmington & Baltimore | 13.50 |
| Philadelphia, Reading & New England | 1.65 |
| Pittsburgh Locomotive Works | 15.00 |
| Porter Locomotive Works | 10.00 |
| Rogers Locomotive Works | 45.00 |
| Richmond Locomotive Works | 9.00 |
| Rio Grande Western | 4.50 |
| Southern | 19.50 |
| Seaboard Air Line | 15.00 |
| St. Louis South-Western | 3.00 |
| St. Paul & Duluth | 9.00 |
| Schenectady Locomotive Works | 15.00 |
| Southern Pacific | 10.50 |
| Toledo, St. Louis & Kansas City | 3.00 |
| Texas & Pacific | 4.50 |
| Toledo & Ohio Central | 10.50 |
| Wabash | 9.00 |
| Wisconsin Central | 9.00 |
| Western New York & Pennsylvania | 12.00 |
| Wheeling & Lake Erie | 6.00 |

# INDEX.

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